Power Engineering

Milesburg—3 Features 54

Power Relief Valve 58

Industrial Gas Turbines 64

Sticking Coal 73

Chimneys and Smoke Control 82

Space-saving rugged

Built, shipped and installed as a compact unit, the new Elliott geared turbine has many advanced features that fit it to the most exacting requirements. Here are some of them:

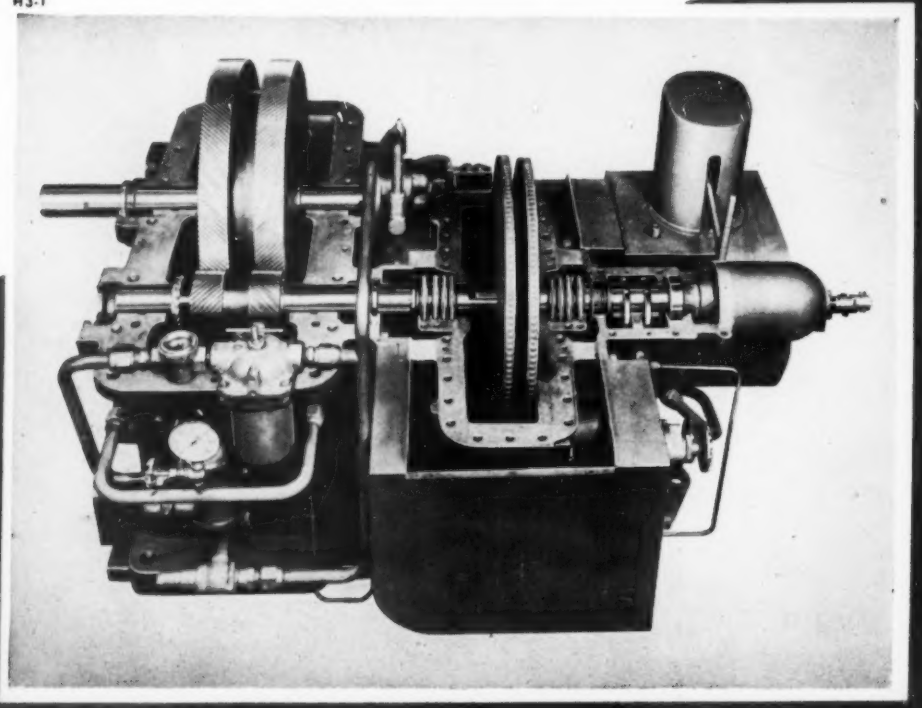
- **Turbine wheels and pinions mounted on a single sturdy high-speed shaft—**
- **Double-helical gears and pinions eliminate end thrust and the need for maintaining critical thrust bearing.**
- **Requires no base plate or external oil reservoir. Three-point support.**
- **Neatly arranged lubrication system, with all external oil piping connected to lower casing.**
- **Liner-type bearings . . . gear-type oil pump, self-priming . . . Kingsbury floating-ring type oil seals with slingers.**

Also built in coupled design, with pinion shaft flexibly coupled to the turbine.

only one of many vital factors in the new

ELLIOTT Geared Turbine

H3-1



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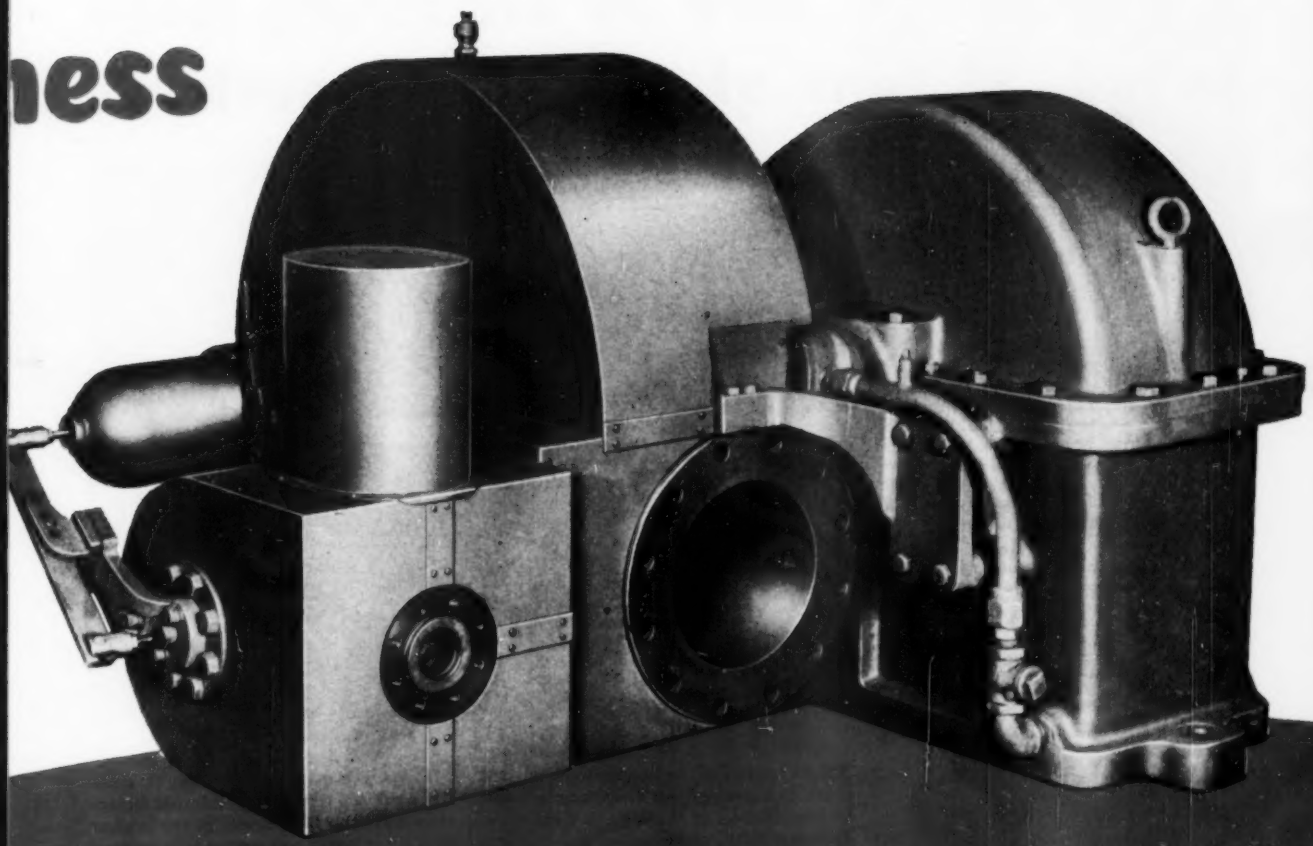


THE TURBINE

The new "built-in" Elliott geared turbine employs the sturdy and dependable YR turbine. This proved turbine design is adaptable to practically all operating requirements and is economical in both operation and maintenance.

Outstanding features are centerline support, stainless steel turbine buckets and shroud, dynamically balanced rotors, and the choice of several governors to be used with the standard overspeed governor. The wide use of standardized parts that fit all sizes of YR turbines simplifies maintenance and the stocking of parts.

Full details on the new Elliott Geared Turbines are given in Bulletin H-19, just released. Bulletin H-16 describes the YR turbine line. Contact your local Elliott district office or write Elliott Company, Jeannette, Pennsylvania.

THE GEARS

Gear and pinion are double-helical (herringbone) type, precision-hobbed, quiet, and long wearing. Tooth spacing is held to extremely close tolerances. Conservative proportioning of the teeth minimizes pinion deflection and permits a uniform, low tooth load.

Both the high-and low-speed gear shafts are provided with an oil slinger combined with a special seal. This design prevents leakage of oil from the gear case and eliminates the infiltration of water, steam, or impurities into the gear case.

All Elliott gears, built-in or coupled, include a self-contained, forced-feed lubrication system which circulates oil under pressure to both gear and turbine bearings. In addition, two spray nozzles in the top gear casing direct a sheet of oil continuously into the meshing point of the gear and pinion teeth, cooling the teeth and lubricating the contact area.

ELLIOTT Company

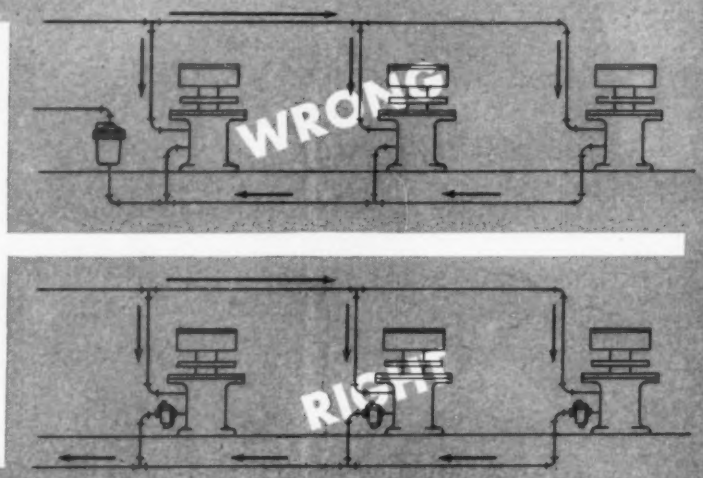
STEAM TURBINE DEPT.

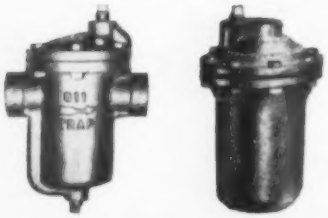
A good trade: How 50 Armstrong traps saved 14 tons of coal per month . . .

User changes from Group Trapping to Unit Trapping

THE drawing labeled "wrong" shows a group of presses drained by a single trap. With this hook-up, condensate and air from one or more presses may fail to reach the trap because even the slightest pressure difference between the units will cause a back flow from a higher pressure unit to a lower pressure unit.

The drawing labeled "right" shows unit trapping, each press drained by a single trap.





Armstrong Steam Traps are available in side inlet-side outlet or bottom inlet-top outlet body styles to best meet your piping requirements.

View of a battery of individually-trapped clothing presses at M. Wile & Company, Buffalo.

AN EXAMPLE of the benefit to be gained from Armstrong Unit Trapping is found in installation at M. Wile & Company, Buffalo, N.Y., clothing manufacturers.

A single steam trap was being used to drain each group of 4 to 6 pressing machines. After changing over to the use of an individual Armstrong trap on each of the fifty presses in the plant, the company reports that, because of the resulting more efficient use of steam, coal consumption dropped by 14 tons a month. There was no reduction in work load. This fuel saving when held up against an investment of about $500 in steam traps was rightly considered *a good trade.*

There are other advantages to Armstrong Unit Trapping. Almost invariably machine temperatures are higher, heat-up is faster and output is increased. The traps themselves are thoroughly reliable, seldom need attention. The design, materials and workmanship in the trap mechanisms for low and medium pressures are identical to those used in Armstrong traps for power plant service at 900 degrees F and 950 lbs. pressure, so they last for a long, long time.

Your local Armstrong Representative will be glad to discuss the savings possible in your plant through Armstrong Unit Trapping. Call him, or write:

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ABC *Acceptance under Section 34.64 P. L. & R., authorized. Publication office, Concord, N. H.*

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MARCH 1953
VOL. 57 • NO. 3

Surrounded by glittering aluminum shavings, these glass bushings at the G. E. Co. transformer plant will be used as insulators

Power Engineering

Here and There with Condor Juan 53

Milesburg—Three Features 54
By W. V. Drake and R. A. Mycoff

Power Relief Valve—Aids Superheater Venting in H-P, H-T Boiler Start-ups 58
By J. W. Mackenzie

Excitation Systems—1953 Style—System Auxiliaries 60
By S. R. Folger

Operating Problems of the Dual Fuel Engine 62
By George Steven

Where Industry Can Use the Gas Turbine 64
By W. C. Bloomquist and W. B. Wilson

POWER ENGINEERING NEWS REEL 66

Dealkalization—Without Acid 68

THE PRACTICAL ENGINEER and ELECTRICIAN Section. Contents 69

Anti-Swing Crane Increases Safety and Accuracy 81

Properly-Sized Chimneys Aid Smoke Control 82
By J. G. Mingle

Operating Experience with Hydro-Plant Valves 84
By William G. Weber

Largest Technical Program Draws 4500 to AIEE Meeting 86

Montana Winter Tests Outdoor Station Design 88

An O-P Goes Dual-Fuel 90

American Power Conference Program 125

REGULAR DEPARTMENTS

Engineers' Preview	7	Catalog Library	130
Helpful Bulletins	35	Construction News	48
Equipment News	42	Letters to the Editors	8

New Engineering Books 122

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ENGINEERS' PREVIEW

ELECTROLUMINESCENCE, the illumination exhibited by a phosphorcoated flat glass panel when subjected to an electromagnetic field, is being explored for the Westinghouse Lamp Division by the two top scientists in the field. Professor Georges Destriau and Dr. Joseph Mattler, both from the Sorbonne, University of Paris, France, have been working in the Lamp Division research laboratories for the past nine months on advanced electroluminescence experiments.

The two scientists began exploring the phenomenon in 1935, more than ten years before American lighting engineers suspected its possible commercial uses. They published joint papers on the basic ideas in 1936. In this country, they have been testing a new superior phosphor. Bringing them here has given Westinghouse scientists the opportunity to get first hand information on the progress of electroluminescence. Professor Destriau has returned to France to continue experiments as a Westinghouse consultant.

E. G. F. Arnott, director of the Lamp Division research laboratories, has stated that the experiments have been most valuable in learning about the lighting qualities of phosphors. As a commercial lighting source, electroluminescence is still just a possibility. Under ordinary conditions it produces only a small amount of light at very low efficiencies.

★ ★ ★

IN A PREVIOUS Council for Technological Advancement bulletin on this subject, No. 2 of September 8, 1952, a brief description of the report of The President's Materials Policy Commission was limited to the technical findings and omitted the Commission's recommendations for public and private action. These recommendations merit careful consideration on the part of industrial equipment manufacturers as many of the recommendations specifically concern legislation in areas highly relevant to their operations, as well as being of a high level of general interest. The recommendations are over seventy in number and cover diverse subjects dealt with throughout the five volume report of the Commission.

In some instances not only the recommendations, but also the premises upon which they are based are highly controversial in nature. Predictions as to the needs and the resources of the economy in the raw materials area some 25 years hence are at best subject to a wide margin of error. But the Commission has made these predictions and has based its recommendations upon them.

This bulletin is an attempt to consolidate the recommendations and to present them in order of their probable significance to industrial equipment manufacturers. Your comments on the Committee's recommendations will be most welcome and should be addressed to the Council for Technological Advancement, 120 South La Salle Street, Chicago 3, Illinois.

★ ★ ★

W. L. VOEGELI has been named to fill the newly created position of assistant director of engineering, Tractor Division, Allis-Chalmers Manufacturing Company, Milwaukee, according to an announcement by W. G. Scholl, vice president in charge of the Division. He will assist A. W. Van Herche, vice president and director of engineering.

Starting with the company at Wichita, Kansas branch in 1935, Voegeli was with the service department at Omaha, Nebraska, and at the home office until he became supervisor of the Technical Publications Department in 1946. He was appointed agricultural tractor sales manager in 1948. He was associated with both industrial and agricultural service sections and when Alcova Dam, the largest earth-filled dam built up to that time, was under construction at Casper, Wyoming, he handled service requirements on Allis-Chalmers industrial tractors there.

★ ★ ★

THE GRISCOM-RUSSELL CO., manufacturer of heat transfer apparatus, has elected Oscar W. Heimberger and Robert M. Wallace as vice-presidents.

Mr. Heimberger, who is now vice-president — engineering, has been in the company's engineering department since 1923 when he was graduated from Ohio State University. Before his recent election as an officer of the Company, he was successively assistant chief engineer and chief engineer.

Mr. Wallace, who is now vice-president — manufacturing, has been with Griscom-Russell since 1928, following his graduation from Brown University. He has advanced through the ranks at the company's plant in Massillon, Ohio, from engineer, welding specialist, assistant superintendent, assistant works manager and works manager.

★ ★ ★

CONSIDERATION is being given to a proposal to merge Public Service Company of Northern Illinois into Commonwealth Edison Company. Under the proposal Public Service, now a subsidiary, would become a division of Edison.

The change would be largely a formal step taken in the interest of simplification of corporate structure since Edison now owns more than 99.8 per cent of the stock of Public Service.

Under the proposal, the business in the Public Service Company territory would be conducted by the Public Service of Northern Illinois Division, with no change in personnel or operations as a result of the move.

★ ★ ★

AN IDEA INTENDED only to make his work easier earned a Thanksgiving harvest of $5000 for a General Electric Company machinist, who today received the highest suggestion award ever made by the company.

Rollo Giles Miller, 5 North Water Street, Gloversville, N. Y., operator of a vertical boring machine in the company's Large Motor and Generator Department in Schenectady, New York, is the winner. Known as "Doc" to his fellow workmen and other friends, Miller suggested a way to machine, with even greater accuracy than before, a thrust bearing which supports the weight of all the rotating parts in a large hydraulic turbine-driven generator.

★ ★ ★

C. M. WILSON, SALES MANAGER, Anemostat Corp. of America, believes high velocity air distribution systems represent a distinct trend. In fact, he believes that within two years, virtually all air conditioning installations of 75 ton size or larger will incorporate high velocity, high pressure air distribution systems.

Speaking at a recent meeting of the Illinois Chapter, American Society of Heating and Ventilating Engineers, Mr. Wilson described high pressure, high velocity systems as those which generally require the use of special devices for the attenuation of sound and dissipation of pressure and velocity near the air outlets. He described a high pressure, high velocity diffuser as essentially a conventional diffuser with a dampering device to reduce pressure, velocity and sound.

After demonstrating how the use of velocities higher than those used in conventional systems results in smaller duct sizes, he mentioned that advantages of this type of system include savings in space required for ductwork, savings in duct material and cost of ductwork, in multi-story buildings savings in floor heights, the elimination of much butchering of existing buildings in order to install air conditioning. An advantage to the contractor which he stresses is the fact that smaller ducts result in reduced labor costs so that a higher percentage of the total job cost is in connection with material and equipment having readily determined costs.

★ ★ ★

DR. RALPH G. OWENS, dean of engineering at Illinois Institute of Technology, has been named vice chairman of the Illinois-Indiana section of the American Society of Engineering Education.

LETTERS TO THE EDITORS

How They Read POWER ENGINEERING

WILL YOU please send me a copy of Dow's Demineralizing Experience, POWER ENGINEERING, June 1951, page 82.

Chicago, Ill. B. NAUMIS

WHILE RECENTLY in the offices of Bituminous Coal Research, Columbus, Ohio, I met Charles H. Marks, who has become associated with them, and he called my attention to an article he had written in the July 1950, issue of POWER ENGINEERING regarding boilers and stokers in England. (Title — Steam Plant Practice in Britain)

Mr. Marks had only his own copy of this issue, and suggested that we contact you to secure a copy, as we are very much interested in this article.

Would you please mail to us either the issue mentioned or a reprint, and any charges will be honored by our company.

Dayton, Ohio R. A. BENESH

WE WOULD appreciate receiving a copy of an article by Wilbur G. Hudson on lubricants, which has been published recently in POWER ENGINEERING.

New York City T. D. PARKER

This was the article Lubrication Adds to Conveyor Life, POWER ENGINEERING, September 1952, page 99.

KINDLY FORWARD me either a reprint or a copy of back issue on the following: Electric Generator Operates at 19,000 rpm, POWER ENGINEERING, December 1950, page 60.

Augusta, Georgia J. K. MOORE

KINDLY SEND me two reprints of the article What Size Driving Motor? by W. R. Harris, November 1952, POWER ENGINEERING.

IRVING TWOMEY

East Hartford, Conn.

IN THE December 1952 issue of POWER ENGINEERING appeared an article entitled Excitation Systems — 1952 Style — Voltage Regulators, by W. A. Hunter and S. R. Folger.

I would like to obtain two copies of this article either in the form of tear sheets, if they are available, or as back copies of the magazine.

Utica, New York H. D. MILLER

Editor's Note: — We could fill pages each month with letters like these. This is just to give you the idea, to show how POWER ENGINEERING is being used by engineers for technical reference, especially in back issues.

IF IT IS POSSIBLE, I would greatly appreciate your sending me a reprint of the following article:

These Tables Speed Up Pipe Sizing — Steam and Water Flow, Pressure Drop, Pipe Size, by A. B. Stickney, *Power Generation* (now POWER ENGINEERING), Vol. 53 — No. 7, July 1949, pp 54–55.

WILLIAM B. SANFORD

Woodward, Ala.

Baffle Repair Gun

WOULD YOU PLEASE supply me with the name and address of one or more companies who make and market a pressure gun for caulking or repairing cracks in boiler furnace baffles?

Some of our baffle repair jobs are in the most hard-to-get-at places, and are almost impossible to perform satisfactorily with hand tools.

I have found your magazine and your services to be very helpful to me in my work in the past, and I am counting on more of the same in the future.

Thanking you for past favors and hoping to hear from you soon,

HAROLD O. PERRY

Manhattan, Kansas

Of course, a list of manufacturers of this equipment went to Reader Perry by return mail. Further comments from readers might help Perry with this problem.

Schedule 160 Pipe

I HAVE READ with interest the data on Schedule 160 pipe in Basic Power Plant Figuring, November 1952 issue. Although the dimensions and elements of the pipe may not have changed during the past 10 years, the allowable stresses and the formula for calculating allowable working pressures have changed.

The Code for Pressure Piping, published in 1951, includes the following formula:

$$t_m = \frac{PD}{2S + 0.8P} + C$$

This differs by an appreciable amount from the formula given on page 78.

In August 1951, *Mechanical Engineering* published new maximum allowable stresses, which are as follows for A-106 pipe:

Temperatures to	*A-106 Gr A*	*A-106 Gr B*
650 F	12,000 psi	15,000 psi
850 F	7,100 psi	7,800 psi

Boston, Mass. G. C. HALZEL

Editor's Note: — The pipe schedule tables for Schedules 40, 80 and 160 pipe previously included in the Basic Power Plant Figuring articles were all made up before the new formula for allowable working pressure appeared in the Code. The author, Mr. Engelmann, is now revising all these pipe data tables in accordance with the latest code recommendations.

Condensate pH

IN READING the January 1953 issue of POWER ENGINEERING, I was especially interested in J. B. Davis' article on How to Make Field Tests for Condensate pH. This is an excellent and timely article and Mr. Davis should be complimented on it.

Unfortunately, there has been a mix-up in the captions of the photographs that may confuse readers.

The sets shown in Figs. 2 and 4, page 84, are identical; that is, both are water analyzers, which are correctly recommended for condensate. The set that is not acceptable for condensate is the comparator shown in Fig. 3.

F. R. McCRUMB

Baltimore, Maryland

Editor's Note: — This confusion can be eliminated by making the following changes in your copy:

Page 84, Caption Fig. 2 should read, "Fig. 2. Shown here is a water analyzer, for making field determination of pH. This procedure will give reliable results with all kinds of waters."

Page 84, Column 3, paragraph 2, sentence 1 should read, "Greater accuracy is secured with colorimetric methods when some type of comparator is used, like that of Fig. 3."

Page 84, Column 3, last paragraph, sentence 1 should read, "One satisfactory way of overcoming this difficulty is to use the water analyzer in which the ratio of indicator to sample is 1:150, as in Figs. 2 and 4."

Sub-station Ownership

IN THE January issue, page 94, you presented one of the most interesting articles I have seen yet: Supplying Power to Industry by F. F. Dickmann of West Penn Power Co. The way in which this utility cooperates with industrial companies deserves the highest praise.

Mr. Dickmann tells how his company helps the customer to select transformers, circuit breakers, etc. This would indicate that the sub-station is owned by the customer and not by the utility.

However, I have recently run across industrial plants in other parts of the country in which the local utility insists on supplying and owning the entire sub-station.

Does this situation vary from utility to utility or is there any general practice in this respect?

Chicago, Ill. AMBITIOUS AL

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4. LOW POUR POINT—an inherent quality that assures fluidity under most operating conditions.

5. FREEDOM FROM CORROSIVE ACIDS AND CORROSIVE SULFUR—helps prevent deterioration of cable materials.

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4. HIGH RESISTANCE TO OXIDATION—because Sun Electrical Oils, as produced, are free of impurities and possess high degree of stability, oxidation is minimized throughout their life.

5. INHERENT LOW POUR POINT—assures fluidity under most operating conditions.

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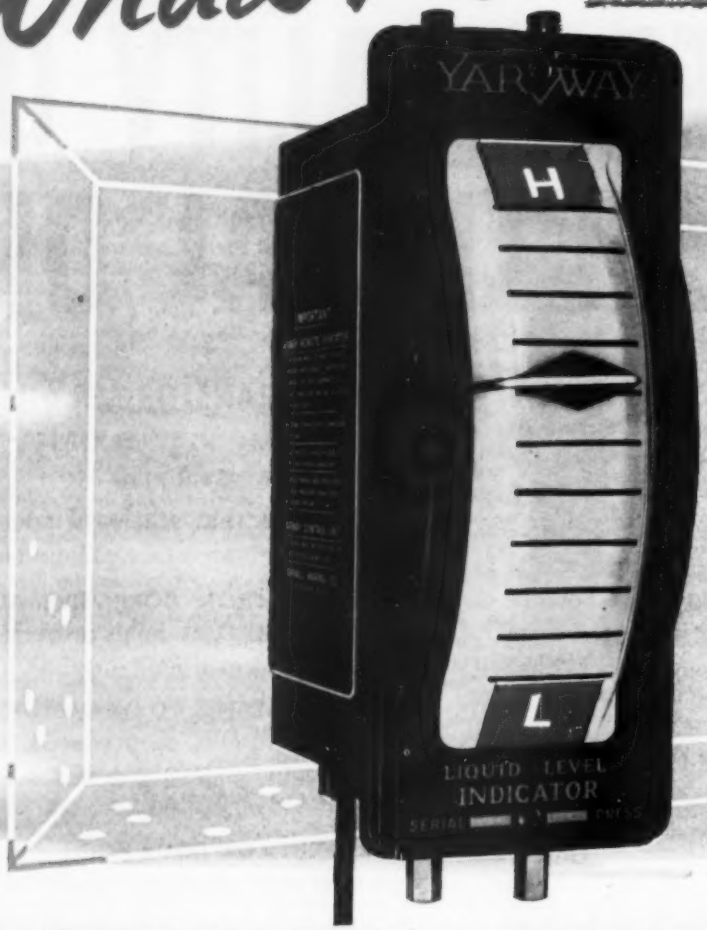

Yarway Remote Liquid Level Indicator, manometric type, with automatic temperature compensation.

IMPROVED *WIDE VISION* REMOTE LIQUID LEVEL INDICATOR

A new-type face on the Yarway Remote Liquid Level Indicator now permits side as well as head-on dial readings. This vastly improved visibility makes it possible to check boiler water levels from most any position in the control room, or wherever the Yarway Remote Indicator may be installed.

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The Yarway Indicator is a manometric type with automatic temperature compensation. Level readings are instant and accurate because the indicator is operated by the boiler water itself. The indicating mechanism is never under pressure. There are no stuffing boxes.

Over 8,000 Yarway Remote Liquid Level Indicators are successfully operating throughout industry—primarily for indicating boiler water levels, but also for many other liquid level applications, and for superheater pressure differential indication aboard ship.

For full information on Yarway Indicators, write for Yarway Bulletin WG-1823.

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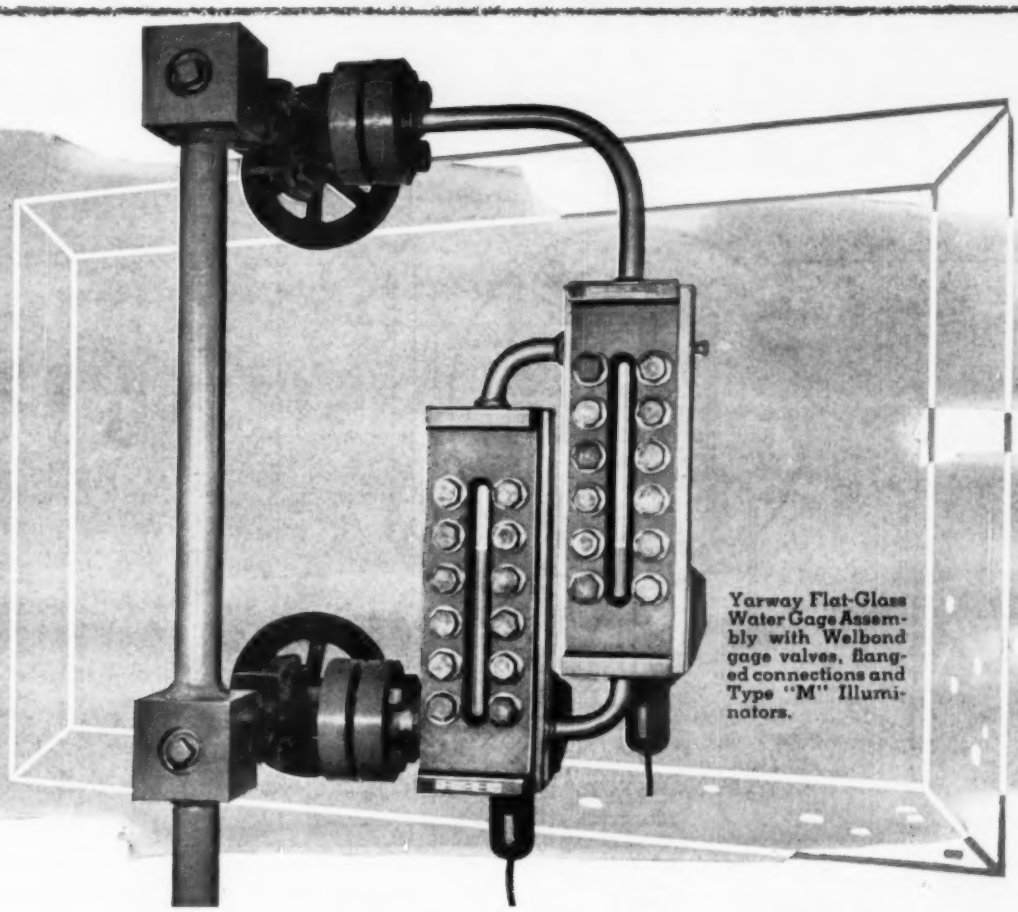


Yarway Flat-Glass Water Gage Assembly with Welbond gage valves, flanged connections and Type "M" Illuminators.

NEW *SEPARATED-DESIGN* WATER GAGES

This new Yarway water gage assembly has been developed to meet the demands for greater dependability, longer life, and more accurate readings in high pressure service.

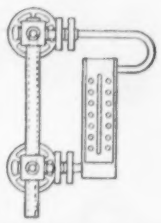
The gage glass inserts are of the Yarway pressure-sealed "floating assembly type". Yarway Welbond gage valves are used. Greater flexibility is gained by using two independent inserts, and by interconnecting expansion loops (see above).

The short connection to the drum assures greater accuracy of the gage reading, and the lower flanged connection eliminates a stuffing box. The upper flanged loop connection between the insert and gage valve allows expansion and contraction of the various components.

The tie bar-type water column linking the gage valves provides circulation to keep gage nearer drum temperature.

Yarway Type "M" Illuminators on the gage inserts cause the meniscus at water level to "shine like a star". This illuminator is especially effective in penetrating deposits on gage glass, dust particles in air and extraneous light.

For full information, write for Yarway Bulletin WG-1811.



Yarway Single Insert type gage for medium range of visibilities.

STEAM PLANT EQUIPMENT

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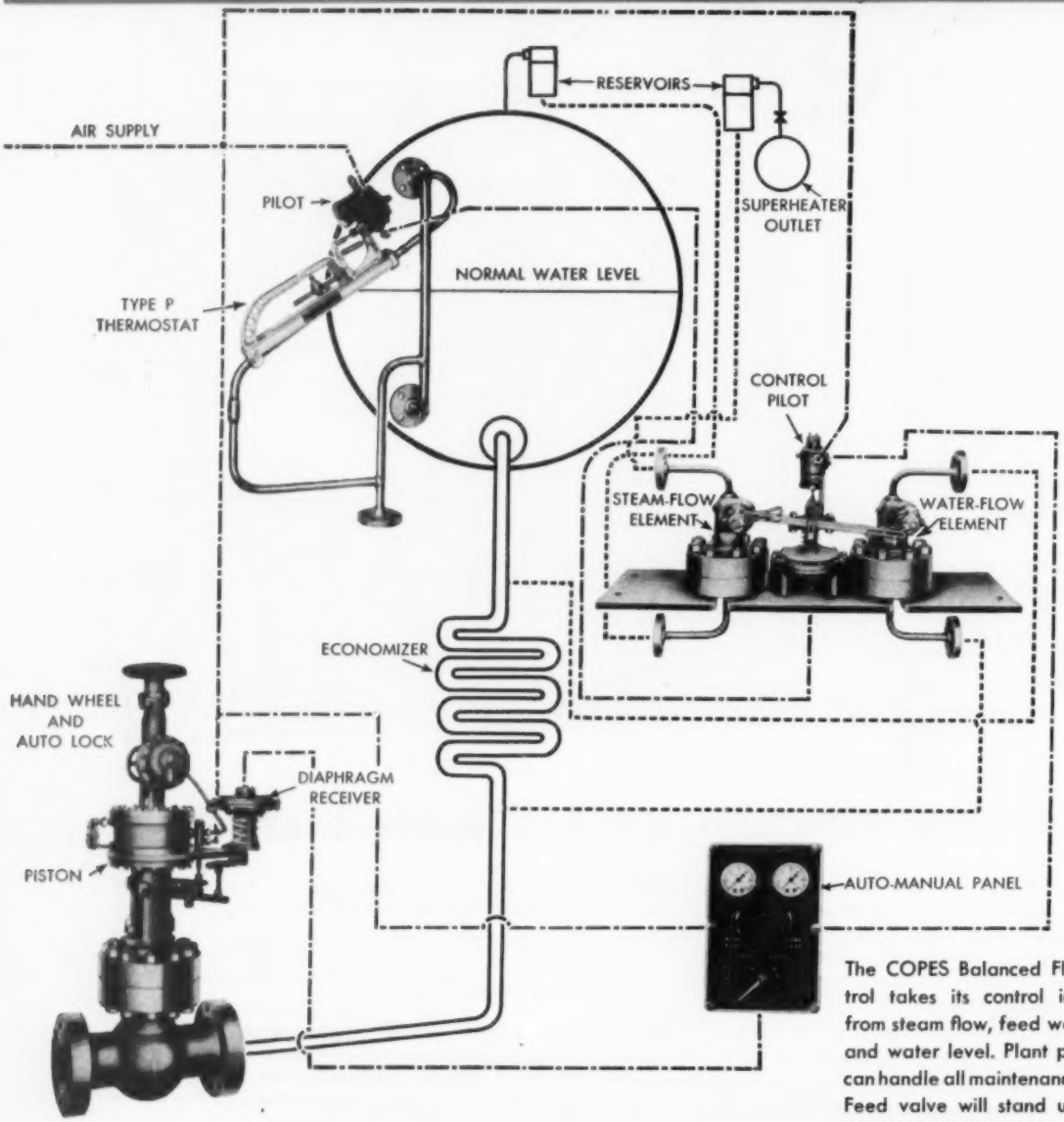
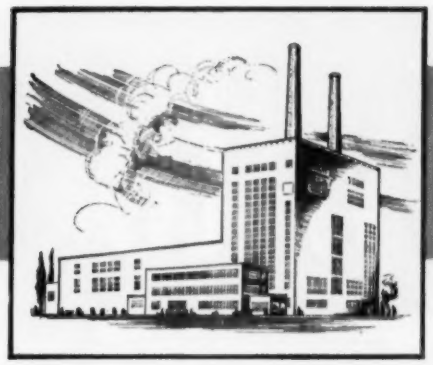


The COPES Balanced Flow Control takes its control influences from steam flow, feed water flow and water level. Plant personnel can handle all maintenance easily. Feed valve will stand up under *unlimited* pressure drops.

COPES

BOILER FEED

COMPANY



The New JUSTIN R. WHITING Plant

orders its 17th COPES Multi-Element Regulator

Add Justin R. Whiting Plant to the growing list of modern stations to have their boiler feeding under COPES Multi-Element Control.

Units 1 and 2, now being erected, will have 2-element COPES Flow-matics applied to hydraulic couplings of the boiler feed pumps.

Unit 3, recently ordered, will have 3-influence COPES Balanced Flow Control as shown schematically.

Whether you prefer one, two or three control influences for feeding your boilers, COPES can give you close level control and correct feed —without depending on any other instruments.

COPES MULTI-ELEMENT REGULATORS AT CONSUMERS POWER COMPANY

PLANT AND LOCATION	BOILER DATA No.	Make	WSP Psi	Max. Cap. Lb. per Hour
B. C. Cobb Plant Muskegon, Michigan...	3	C-E	875	600,000
Elm Street Plant Battle Creek, Michigan.	1	B & W	850	360,000
Bryce E. Morrow Plant Comstock, Michigan....	2	F W	875	400,000
	1	F W	875	550,000
	1	F W	875	600,000
John C. Weadock Plant Bay City, Michigan....	2	F W	875	400,000
	2	F W	875	550,000
	2	F W	875	600,000
Justin R. Whiting Plant Erie, Michigan.....	2	B & W	1600	690,000
	1	B & W	1600	860,000

COPES-VULCAN DIVISION
CONTINENTAL FOUNDRY & MACHINE COMPANY
ERIE, PENNSYLVANIA

WATER REGULATION

For more data circle 506 on Post Card

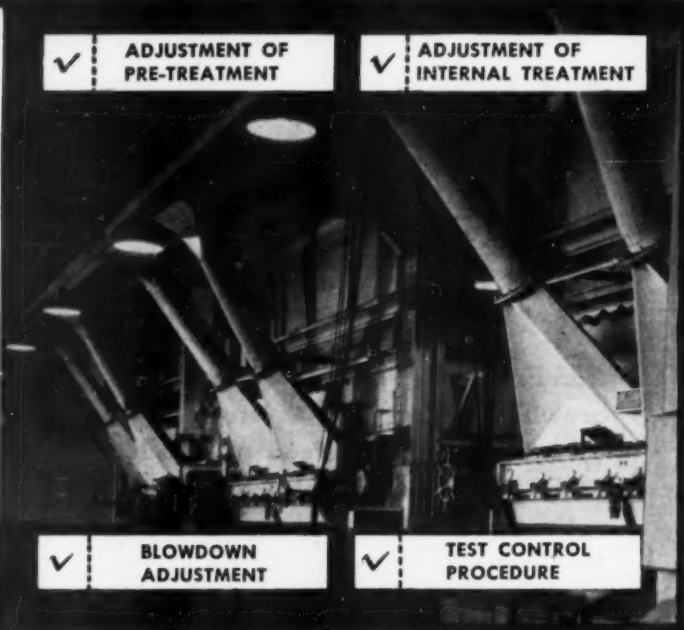
How to Combat

with Dearborn's complete water treatment and engineering service

Providing trouble-free water—a vital necessity to every user of steam—has been Dearborn's business for more than 65 years.

Today, this broad background of experience—plus treatment formulas that have been tested and re-tested and the most modern laboratory and research facilities—are available to you at Dearborn.

To keep your power and steam-producing facilities at peak production... to greatly minimize unnecessary maintenance—call your Dearborn Sales Engineer. He's our expert who will check your facilities—analyze your raw water—recommend the proper treatment, feeding equipment and test procedure. Dearborn Bulletin 5000 completely describes this service.



with Dearborn Engineered treatment equipment

Plus results from water treatment frequently depend on feeding equipment.

Here, too, Dearborn can help you. Your Dearborn Sales Engineer will inventory your existing equipment... your plant layout...then make recommendations to help you increase efficiency by including a pump or timer...a test cabinet...or an automatically controlled feeding system. Ask for Bulletin 5000.

Dearborn

TRADE MARK

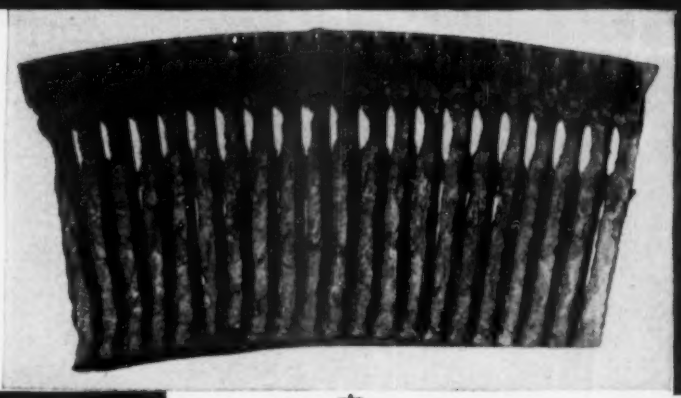
COMBATTING CORROSION EVERYWHERE SINCE 1887

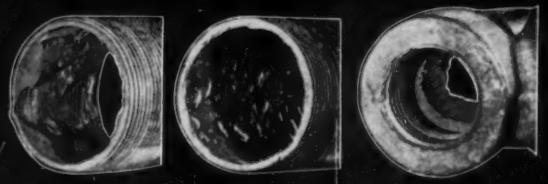
DEARBORN CHEMICAL COMPANY · Merchandise Mart Plaza, Chicago 54, Illinois

Water Problems

with Dearborn polyamide anti-foams

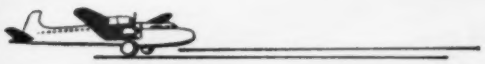
Equipment-damaging sludge formations in feed lines, heaters, generators can be eliminated with Dearborn Polyamide Anti-Foam No. 659. Prevents carry-over of suspended and dissolved solids... conditions sludge ... is compatible with other treatment. Dearborn Bulletin 5008 demonstrates how you can have this purer steam.





with Dearborn Filmeen to prevent return line corrosion

Replacement of valuable parts—destroyed after but a short service life—could have been prevented with Dearborn Filmeen... an exclusive Dearborn development that forms a continuous amine-type film on return lines to prevent corrosion. Dearborn Bulletin 5013 tells the complete story.



Greater Pittsburgh airport is protected by Dearborn's anti-corrosion services

To eliminate corrosion and reduce maintenance expense, the new, greater Pittsburgh Airport relies on many Dearborn water treatment and rust preventive products and services. Your Dearborn Sales Engineer will do the same for you... call him... no obligation, of course.

Dearborn Chemical Company, Dept. PG
Merchandise Mart Plaza, Chicago 54, Ill.

Please send me:

☐ Bulletin 5000 ☐ Bulletin 5013
☐ Bulletin 5008 ☐ Have a Dearborn Sales Engineer call

Name.....

Company.....

Position.....

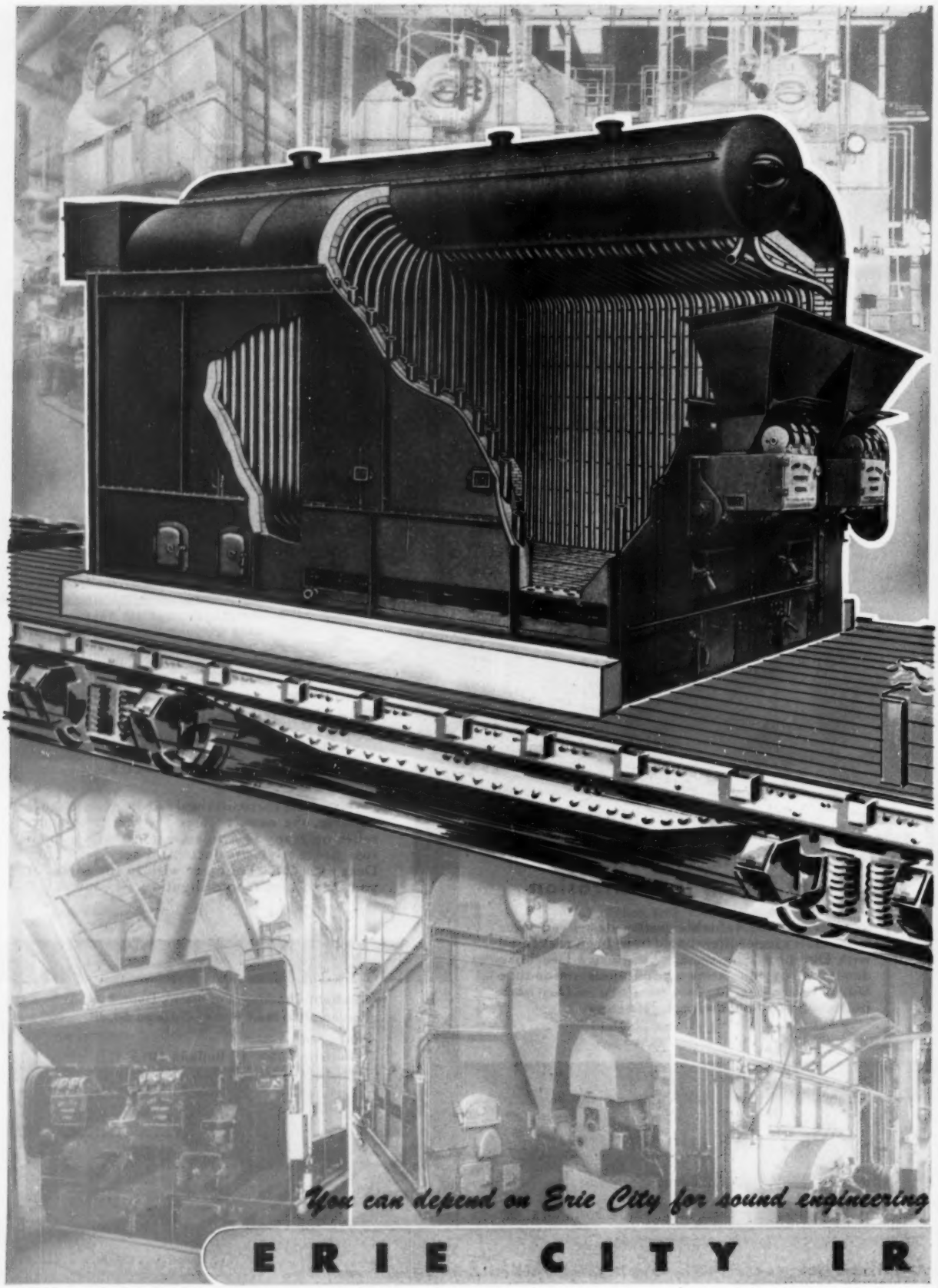
Address.....

City.....*Zone*.....*State*.....

DEARBORN ALSO SUPPLIES

- New, High-Capacity Exchange Minerals
- De-Ionizing Systems and Zeolite Softeners
- Dearsol—The New Fuel Oil Additive

For more data circle 507 on Post Card


You can depend on Erie City for sound engineering
ERIE CITY IR

Here's Another ERIE CITY VL STEAM GENERATOR

Stoker and 300 hp. VL boiler are shown combined but are shipped as two units.

This one, fired by the Erie City Dumping Grate Spreader Stoker. Erie City VL's by the hundreds are serving a broad cross section of small to large steam users. These completely factory-assembled or field erected steam generators incorporate a 2-drum boiler and integral water cooled furnace for any mechanical firing method. We draw upon a 50 year experience with 2-drum boilers and a pioneering application of water wall design that keeps refractory maintenance to a minimum.

Only clean water can enter the integral water wall circulation. VL's are the most accessible boilers of this type—easy to keep clean and at top efficiency. Hospitals, Schools, Institutions, Dairies, Laundries, Industries and Process Plants use and repeat on VL's.

ERIE CITY IRON WORKS • *Erie, Pa.*

STEAM GENERATORS • SUPERHEATERS • ECONOMIZERS • AIR PREHEATERS
UNDERFEED AND SPREADER STOKERS • PULVERIZERS

A Few of the Hundreds of Erie City VL Users

BORDEN CO.
DAIRYMAN'S LEAGUE
ARMOUR & CO.
KRAFT FOODS CO.
GENERAL MILLS CO.
REPUBLIC STEEL CORP.
BORG WARNER CORP.
ALUMINUM CO. OF AMERICA
GENERAL ELECTRIC CO.
UNION PACIFIC R. R. CO.
HERCULES POWDER CO.
ARCHER DANIELS MIDLAND CO.

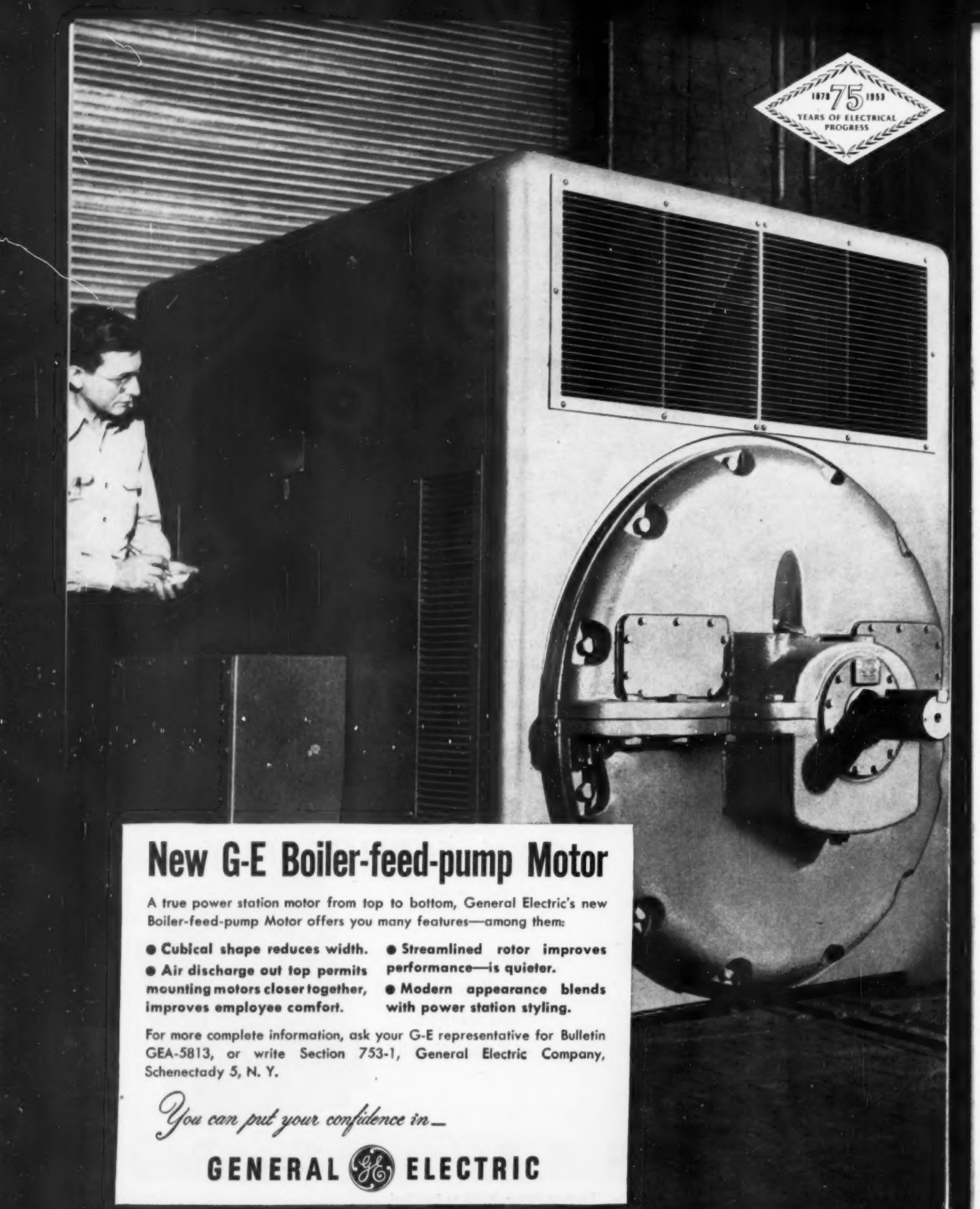
Get the COMPLETE STORY . . .

on this modern 2-DRUM Steam Generator for all mechanical firing methods.

Ask for **SB-43B**

ON WORKS • *Erie, Pa.*

For more data circle 508 on Post Card



New G-E Boiler-feed-pump Motor

A true power station motor from top to bottom, General Electric's new Boiler-feed-pump Motor offers you many features—among them:

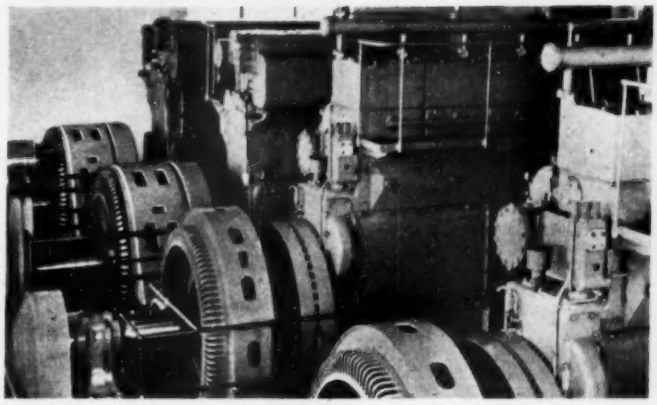
- **Cubical shape reduces width.**
- **Air discharge out top permits mounting motors closer together, improves employee comfort.**
- **Streamlined rotor improves performance—is quieter.**
- **Modern appearance blends with power station styling.**

For more complete information, ask your G-E representative for Bulletin GEA-5813, or write Section 753-1, General Electric Company, Schenectady 5, N. Y.

You can put your confidence in—

GENERAL ELECTRIC

"12,000 H.P. Hours per Gallon with Sinclair RUBILENE"



... says Leo D. Bradley, Manager
Western Michigan Electric Co-operative, Scottville, Michigan

"Our two Cooper Bessemer super-charged 1600 H.P. Model LS8T diesels deliver over 12,000 H.P. Hours per gallon of Sinclair RUBILENE H.D. Oil consumed," says Leo D. Bradley.

"We give much of the credit to the quality of this oil," continues Mr. Bradley. "RUBILENE® keeps our diesels exceptionally clean. Wear is kept at a minimum – the result is high efficiency ... low operating costs ... and low maintenance cost."

Sinclair Products have been used since the generating station first went into operation – 12 years ago. The recommendations made by a Sinclair Lubrication Engineer at that time plus continuous counseling service and superior Sinclair Products have meant substantial savings for this co-operative.

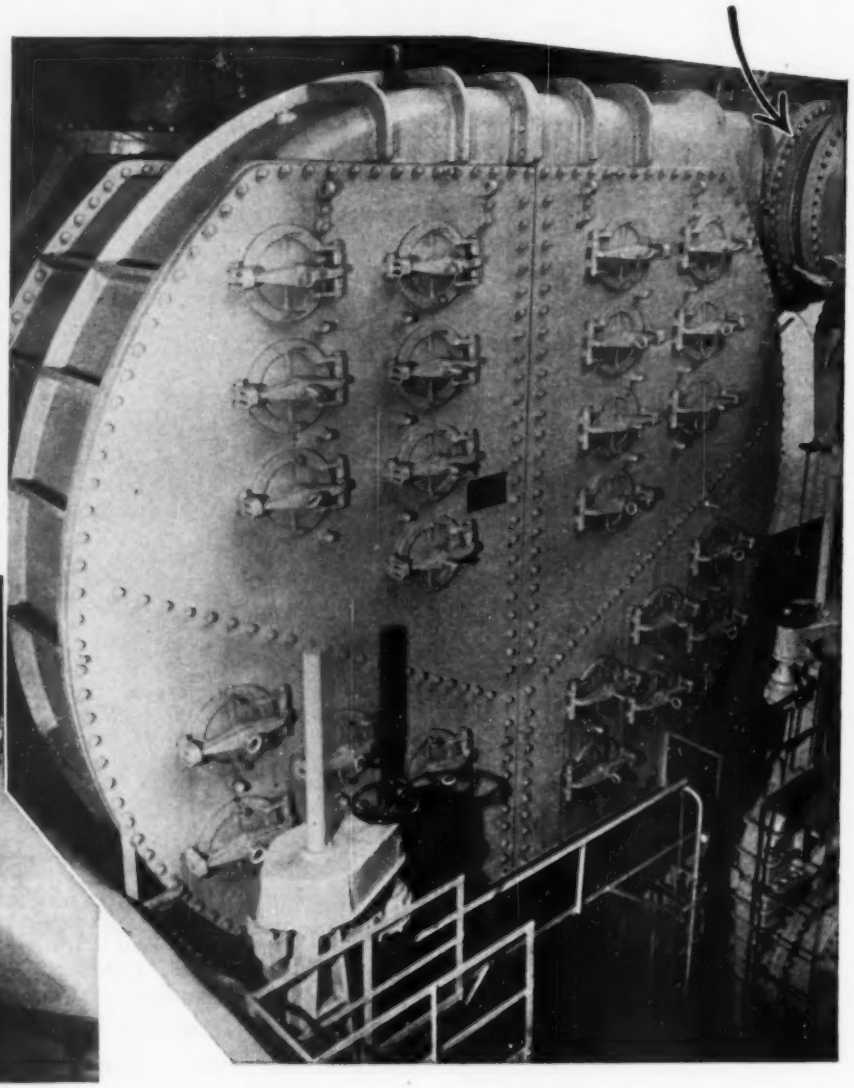
Perhaps a Sinclair Lubrication Engineer can help solve some of your lubrication problems. Phone your local Sinclair Representative or write to Sinclair Refining Company, 600 Fifth Avenue, New York 20, N. Y.

SINCLAIR DIESEL LUBRICANTS

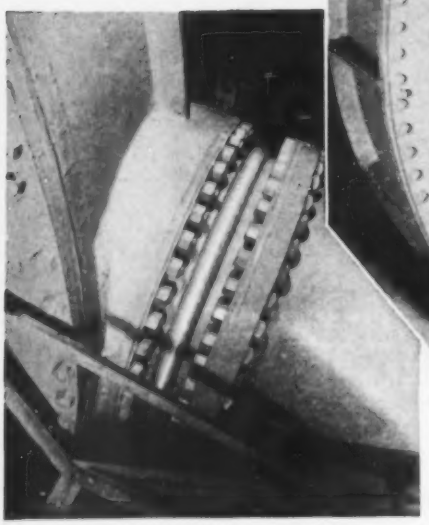
prolong engine life

For more data circle 510 on Post Card

After 20 years, the same U. S. Rubber Expansion Joints still protect this condenser



Main power plant condenser, showing 72" U. S. Rubber expansion joint on discharge pipe at upper right. Lower photograph shows close-up of 42" expansion joint on intake connection.



That's a long time in any industry. This southeastern power plant still gets perfect service from these U. S. Expansion Joints. Pipes are protected from expansion and contraction and the effects of vibration. It's easy to see why this plant, like so many others throughout the nation, uses "U. S." Expansion Joints exclusively. Let U. S. Rubber engineers help you handle your expansion joint problems.

PRODUCTS OF U.S.RUBBER SERVING THROUGH SCIENCE

UNITED STATES RUBBER COMPANY

MECHANICAL GOODS DIVISION • ROCKEFELLER CENTER, NEW YORK 20, N. Y.

For more data circle 511 on Post Card

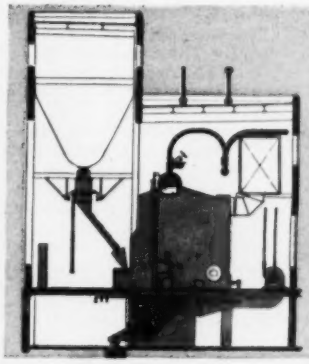
"74.2% MORE STEAM PER DOLLAR—

that's what this modern coal installation gives us at Perfection Stove Co.!"

says George I. Chittenden, consulting engineer for the Perfection Stove Company.

Perfection's old installation, if operating today, would generate 1,362 lbs. of steam per hour per dollar. The new plant produces *2,373* lbs. of steam per hour per dollar. Here's proof of the economy and efficiency of bituminous coal burned with modern equipment.

This view of Perfection Stove's new steam plant shows the coal elevator and ash silo. Coal is delivered through an under-track hopper, lifted by elevator to storage. A pneumatic system carries ashes to the silo.



This sectional drawing of the plant's boiler installation shows the coal bunker over the firing aisle. A weigh larry with dust-proof connection feeds coal to the stokers. The plant is clean and efficient—typical of the modern design that makes full use of coal's inherent advantages.

If you operate your own steam plant, you can't afford to ignore these few down-to-earth facts!

COAL in most places is today's lowest-cost fuel.

COAL resources in America are adequate for all needs—for hundreds of years to come.

COAL production in the U.S.A. is highly mechanized and by far the most efficient in the world.

COAL prices will therefore remain the most stable of all fuels.

COAL is the safest fuel to store and use.

COAL is the fuel that industry counts on more and more—for with modern combustion and handling equipment, the inherent advantages of well-prepared coal net even bigger savings.

● More and more consulting engineers are advising their clients that *bituminous* coal is the best buy for steam fuel. *Here's why:* Nearly everywhere coal yields more BTU's per dollar . . . modern combustion installations step up this inherent economy . . . up-to-date coal- and ash-handling systems cut labor costs to a minimum.

Tremendous reserves give coal a future dependability of supply no other fuel can offer. And to mine this coal, America has the world's most productive and efficient coal industry—making coal the one fuel most likely to remain reasonably stable in price.

If you're building or planning to modernize a steam plant, call in a competent consulting engineer. He'll show you how a modern coal installation can save you money and do a more efficient job, too!

BITUMINOUS COAL INSTITUTE
A Department of National Coal Association
WASHINGTON, D. C.

FOR HIGH EFFICIENCY FOR LOW COST

YOU CAN COUNT ON COAL!

For more data circle 512 on Post Card

Revolutionary Performance!

Riley Boiler Unit gives bonus of 20,000 pounds per hour of steam to Masonite Corporation

Here's the maximum capacity guaranteed to Masonite by Riley Stoker Corporation:

50,000 lb. continuous
60,000 lb. for 15 min. peaks

And here's the Masonite report on performance: "For the past 75 days the average hourly load on the new boiler has been 70,000 pounds with peaks of one and more hours' duration of 75,000 pounds."

This same installation called for a guaranteed air heater gas temperature not in excess of 395 degrees at 50,000 pounds of steam per hour. In actual operation at 54,500 pounds of steam per hour, the air heater exit gas temperature was only 377.5 degrees!

No wonder Riley Stoker Corporation, Worcester, Massachusetts, is so well known among leading plants throughout the nation for the highly efficient performance of its boilers!

Coppus-Dennis FANMIX Burners Were Installed

To assure such revolutionary performance, Riley specified Coppus-Dennis FANMIX Burners for its boilers. The exclusive FANMIX action — on *all* Coppus burners, gas as well as combination gas-oil — is the reason for such performances.

FANMIX : Better Combustion : Better Efficiency : Higher Ratings

FANMIX burners, with their *revolving orifices*, give violent mechanical mixing and agitation of gas and air and, therefore, instantaneous and complete combustion with *minimum excess air* (5% excess air not unusual).

Furnace space is not required for mixing; therefore, *higher boiler ratings* are easily obtained.

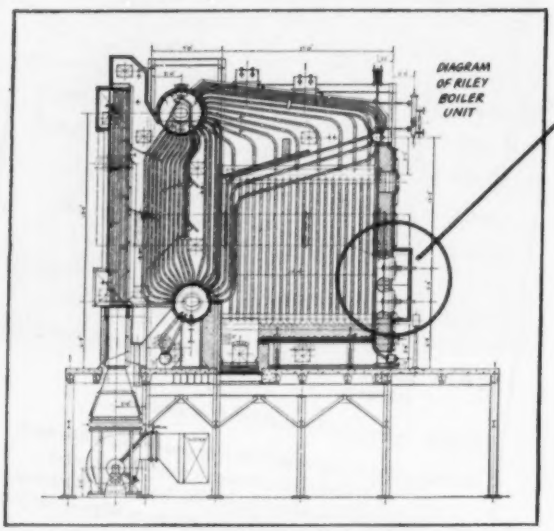
FANMIX burners, with shorter flame than any other burner, cannot cause flame impingement.

FANMIX burners, incorporating a *fan* as an integral unit, have *no draft loss* across the burner. Therefore, regardless of draft conditions, increased ratings are possible.

FANMIX action, with its quick completion of combustion, gives *lower* exit gas temperatures.

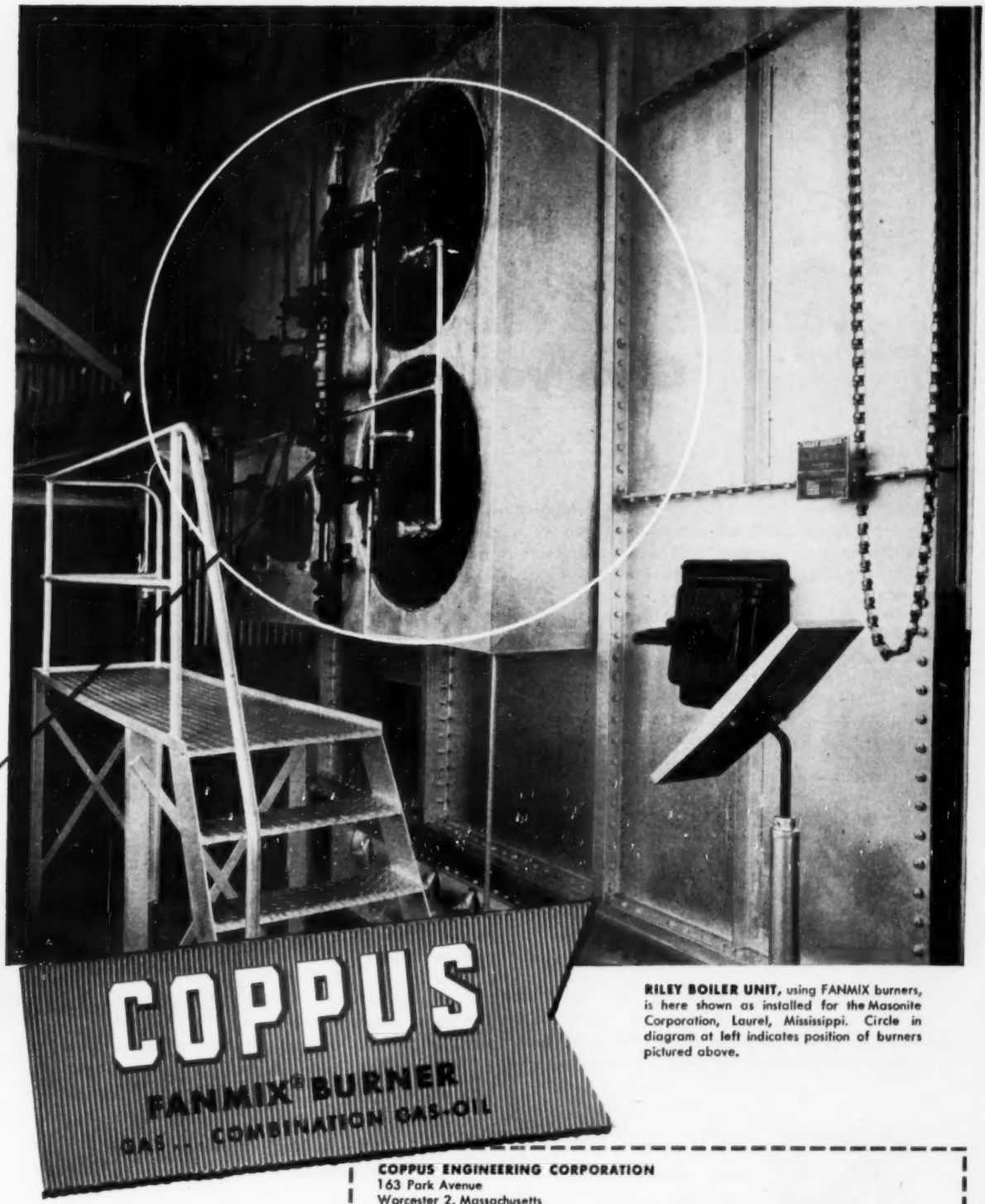
Plan now to take advantage of Coppus-Dennis FANMIX action with your present boiler. Remember — no forced draft equipment nor increase in stack nor increase in furnace volume is required for *FANMIX* operation to get increased capacity. And on *new* boilers, FANMIX lets you plan on reduced combustion space, higher ratings, less stack height or reduced induced draft capacity, and *no* forced draft equipment. Mail coupon today. Sales offices in *Thomas' Register*. Other "Blue Ribbon" Products in *Chemical Engineering Catalog, Refinery Catalog, Best's Safety Directory, and Mining Catalogs*.

JET REACTION is utilized to rotate fan which is integral part of burner. Automatically proportioned high velocity air passes at right angles through fuel to create ideal mixture for fast, complete combustion and peak efficiency.



Well-Known Users of Riley Units with FANMIX Burners Include:

Publicker Commercial Alcohol Co.
Monsanto Chemical Co.
Gaylord Container Corp.
Commercial Solvents Corp.
Celanese Corp. of America
Gulf Power Co.
Mississippi Power Co.
Eagle-Picher Lead Co.
Humble Oil & Refining Co.
Godchaux Sugars, Inc.
Kennecott Copper Corp.
Nicholson File Co.
Bird & Son, Inc.
— and many others



RILEY BOILER UNIT, using FANMIX burners, is here shown as installed for the Masonite Corporation, Laurel, Mississippi. Circle in diagram at left indicates position of burners pictured above.

SEND COUPON for further information. Coppus engineers FANMIX burners to your individual requirements.

PLEASE ATTACH THIS COUPON TO YOUR COMPANY LETTERHEAD

COPPUS ENGINEERING CORPORATION
163 Park Avenue
Worcester 2, Massachusetts

Please send complete data on Coppus-Dennis FANMIX Burners. I'm particularly interested in
☐ gas ☐ combination gas-oil.

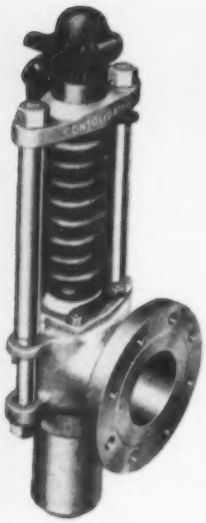
Name..... Title.....

Company.....

Address.....

City..... Zone..... State.....

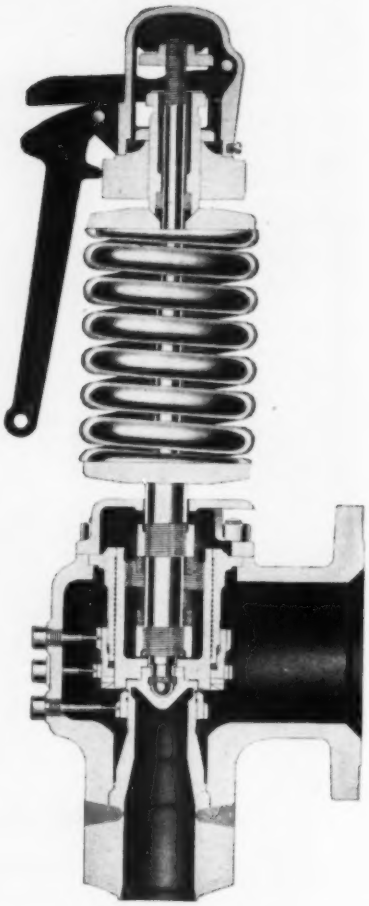
For more data circle 513 on Post Card



MAXIMUM FLOW...

CONSOLIDATED *Maxiflow* SAFETY VALVES

Give you that—and more!



GREATER DISCHARGE CAPACITY that is there *when you need it* . . . tightness that you can depend on *month-after-month* . . . and other design features for high pressure, high temperature service mean one valve only — the Consolidated *Maxiflow* Safety Valve.

You can rely on the Maxiflow. Punishing laboratory tests and the toughest field services have demonstrated the functional ruggedness and dependability of the Maxiflow. Design advantages include:

Thermodisc Seat For Permanent Tightness. Equalizes temperature differentials when the valve reseats after blowing, minimizes thermal stresses, prevents seat distortion.

Design And Materials Assure Retention Of Popping Point. Special alloy steel is used to obtain stability of the spring support in the yoke rods, and a stainless steel spindle compensates thermally for any possible elongation of other parts that effect spring loading.

Controlled Blowdown. Simply and externally adjusted while the valve is under pressure.

Forged Mechanical Through Bushing. Provides constant entrance conditions for steam flow. There is no leakage due to porous castings.

Whatever size safety valve you need — 1½", 2", 2½", 3", or 4" — choose Consolidated *Maxiflow*, the safety valve that sets a new standard in protection and service. Complete data, including capacity tables, are available in Bulletin 707. Write for a copy.

CONSOLIDATED SAFETY VALVES

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONN.

MAKERS OF 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'HANCOCK' VALVES, 'ASHCROFT' GAUGES. BUILDERS OF "SHAW-BOX" CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.

For more data circle 514 on Post Card

Reduce Solids Concentration *with* EFFECTIVE BLOWDOWN

ALLIS-CHALMERS WATER CONDITIONING
Equipment — Chemicals — Service

You Need An Effective blowdown schedule to reduce solids concentration and limit heat losses in your system. Planning your schedule is easier after you've read Allis-Chalmers water conditioning Bulletin 53. It tells how to choose between a manual and a continuous system. It explains factors involved in sludge removal. And it discusses effects of alkalinity and silica concentration.

Part of Practical Library

Bulletin 53 is one of a series of Allis-Chalmers bulletins on water conditioning problems. These bulletins are the result of Allis-Chalmers experience in solving water problems for every industry, as well as the company's long background in the design and manufacture of steam turbine and power plant equipment.

Get Complete Service

Allis-Chalmers offers complete water conditioning service. You can get analyses and reports on your problems. You can get chemicals needed in all water treatments. And you can get equipment needed for any system.

COMPLETE TEST KITS for making standard feedwater and boiler water tests are supplied by Allis-Chalmers for field use. When needed, modern testing equipment and research facilities are available in A-C laboratories.

For your copy of Information Bulletin 53 on blowdown, write Allis-Chalmers, Milwaukee 1, Wisconsin. Or better, call your nearby A-C district office to have an Allis-Chalmers representative consult with you on your water problems.

A-4008

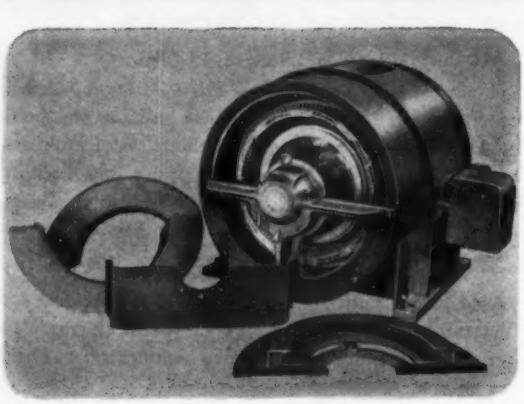
ALLIS-CHALMERS

A-C ALLIS-CHALMERS

For more data circle 515 on Post Card

Below is a typical forced-ventilated installation. Motor can be arranged so ducts can be brought in at any angle.

Lucite window makes brush inspection easy. Simply remove window for quick entrance to brushes . . . for checking and inspection and maintenance.



Light, sturdy end covers and air shields are easily and quickly removed for inspection and cleaning. No crane is required. One man can do the job easily.

MORE POWER PER DOLLAR

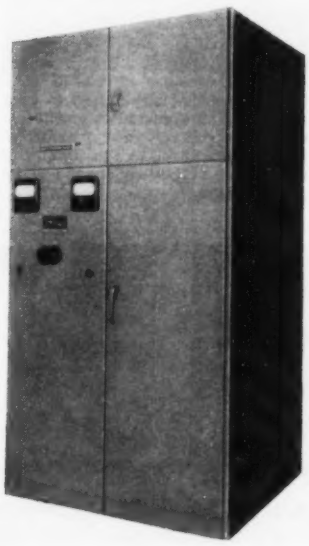
Synchronous Motor Offers New Installation Flexibility

When forced ventilation is required you can eliminate many installation problems with this synchronous motor. Air is supplied to the motor from both ends through air inlet brackets . . . two at each end, on either side. Duct or pipe connections can be brought from above . . . from below . . . from one side or the other . . . or a combination. Thus, you can position the motor without regard for duct work.

Covers and air shields, too, add to installation flexibility. They can be easily removed — by hand — for inspection or cleaning of the motor. No crane is required. Thus motors can be mounted in hard-to-reach places.

This added installation flexibility may open up new opportunities to save money with synchronous motors. In many cases, these motors will improve your power factor and reduce your power bill. They provide more power per dollar for many types of drives than any other motor.

Get all the facts on Westinghouse Synchronous Motor savings. Ask your Westinghouse representative for information on the simplified inspection and servicing these motors offer. Complete information is available. Ask him for a copy of DB-3200 or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-10354-A



YOU CAN BE SURE...IF IT'S Westinghouse

Matched control for the motor. This Slipsyn Synchronous Motor Control protects your motor investment . . . helps you get more for your power dollar.

For more data circle 506 on Post Card

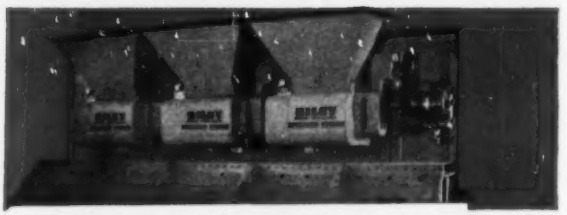
What has caused this tremendous SWING to Riley Traveling Grate Spreader Stokers?

As more and more Riley Traveling Grate Spreader Stokers have been placed in operation Riley Spreader Stokers are being selected by greater and greater numbers of the country's leading public utility and industrial plants—to such an extent that Riley sales in 1952 were more than four times 1950 sales and fifty per cent greater than in 1951 though total boiler and stoker industry sales were appreciably lower.

We believe the fundamental reason for this tremendous swing to Riley is that news of the excellent results and satisfactory performance of Riley Spreader Stokers has traveled rapidly from plant to plant. Such satisfactory performance is largely due to design characteristics and the vast experience of Riley in the stoker field.

Minnkota Power Cooperative, Inc.
Grand Forks, North Dakota
Two Riley Traveling Grate Spreader Stokers

THE GRATE SURFACE The grate surface is made up of small clips, two inches wide by six inch pitch, mounted on structural T bars. The use of small grate clips eliminates warping and cracking and assures low maintenance and long life by providing adequate cooling. Clips are of nickel-chrome alloy to minimize growth. A level grate surface and uniform air distribution results.



THE FEEDER-DISTRIBUTOR The feeder is designed to give uniform positive feed regardless of coal characteristics and moisture. Avalanching with fine coal does not occur. The overthrowing distributor gives uniform longitudinal and lateral distribution and prevents damage and outage caused by wedging of foreign materials between distributor and housing.

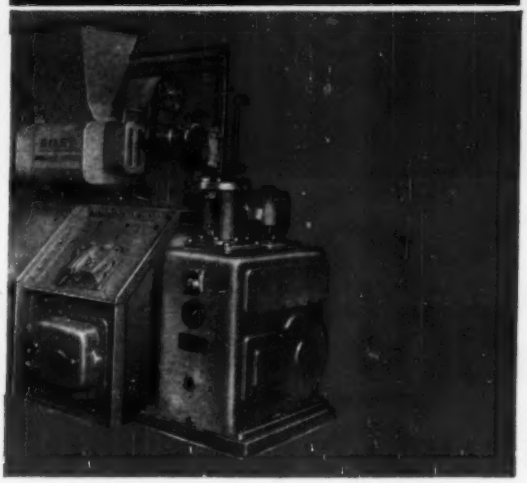
TRADE MARK Rx REGISTERED

RILEY

STOKER CORPORATION, WORCESTER, MASS.

Boston · New York · Philadelphia · Washington · Buffalo · Pittsburgh · Cleveland · Detroit · Chicago
Cincinnati · Charlotte · Atlanta · New Orleans · St. Louis · Kansas City · St. Paul · Tulsa · Houston
Denver · Salt Lake City · Los Angeles · Portland · Seattle

BOILERS · PULVERIZERS · BURNERS · STOKERS · SUPERHEATERS · ECONOMIZERS



THE GRATE DRIVE The Riley grate drive is a hydraulically driven ratchet drive, completely enclosed and automatically lubricated. This simple rugged drive operates with practically no maintenance and is not susceptible to damage in case of grate obstruction. No sprockets, chains or speed reducers are required.

BACKED BY OVER 50 YEARS OF EXPERIENCE
There are over 50 years of stoker designing and manufacturing experience back of the Riley Traveling Grate Spreader Stoker, dating back to the two first successful makes of stoker—the Murphy Furnace and the Jones Underfeed Stoker. Riley has been manufacturing traveling grate stokers for over 30 years.

We believe it will pay you to visit some installations before purchasing traveling grate spreader stokers.

All of these Companies have ordered Riley Traveling Grate Spreader Stokers

Montana-Dakota Utilities
Mandan, North Dakota

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Houghton, Michigan

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South Bend, Indiana

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Maui, Hawaii

General Motors Corp.
Saginaw Steering Gear Div.
Saginaw, Michigan

White Pine Copper Co.
White Pine, Michigan

Electrica De Bogota
Bogota, Colombia

Ohio Edison Co.
Youngstown, Ohio

City of Painesville
Painesville, Ohio

Carbide & Carbon Chemical Company
Whiting, Indiana

Ohio Edison Company
Springfield, Ohio—two orders

Iowa-Illinois Gas & Electric Company
Iowa City, Iowa

Celanese Corp. of America
Hopewell, Virginia

Cliffs Power & Light Company
Ishpeming, Michigan

Iowa Public Service Company
Carroll, Iowa

Kennecott Copper Company
McGill, Nevada

General Electric Company
Richland, Washington

Garlock Packing Company
Palmyra, New York

Swift & Company
Baltimore, Maryland

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Savannah River Project, South Carolina

Kaiser-Frazer Company
Willow Run, Michigan

B. F. Goodrich Company
Akron, Ohio

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Washington

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Lancaster, Pennsylvania

Pennsylvania Electric Company
Seward, Pennsylvania—three orders

Ohio Edison Company
Youngstown, Ohio

Ottertail Power Company
Crookston, Minnesota

Champion Paper & Fibre Company
Canton, North Carolina

Central Illinois Light Company
Springfield, Illinois

Monsanto Chemical Company
Springfield, Massachusetts

General Electric Company
Louisville, Kentucky

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A survey of your Power Plant by a consulting engineer will possibly show ways of making surprisingly large savings in your power costs

COMPLETE STEAM GENERATING UNITS

. . . it will pay you to visit modern Riley Installations before purchasing Boiler or Fuel Burning Equipment

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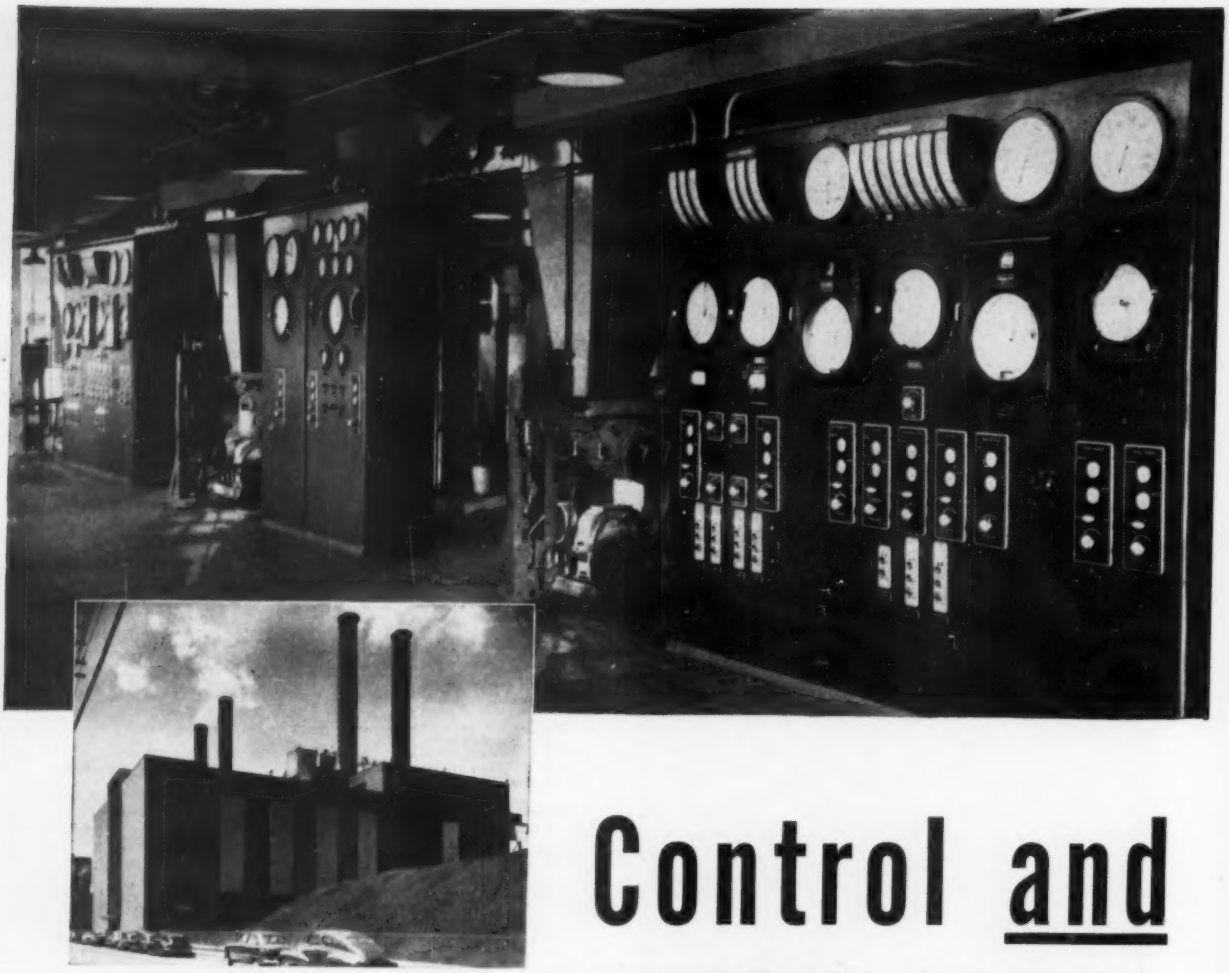


The Jamestown plant is efficient and modern, inside and out.

Control and

AT JAMESTOWN, NEW YORK MUNICIPAL LIGHT PLANT

Another Central Station
Where REPUBLIC Automatic Combustion Controls:

SAVE FUEL by maintaining maximum combustion efficiency continuously.

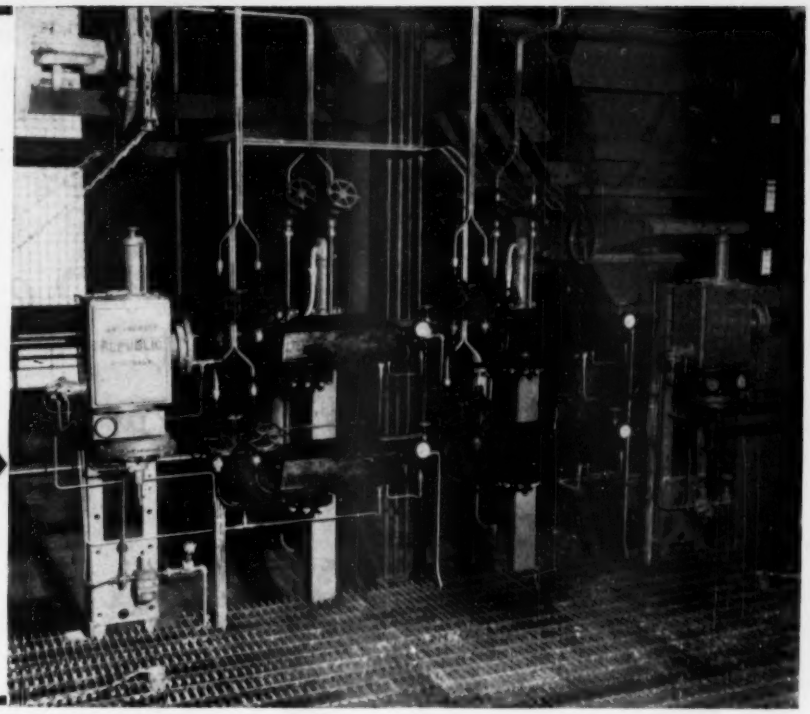
SAVE MAINTENANCE AND EQUIPMENT by holding uniform operating conditions. Chain-of-event type of trouble that frequently develops as a result of incorrect boiler operation is prevented.

SAVE MANPOWER by automatically performing many repetitive adjustments.

HIGHLY IMPORTANT during this critical power shortage, the Jamestown plant meets peak load demands because, with REPUBLIC Combustion Controls, it gets all of the steam output the plant boilers are rated for.

These panels are part of the REPUBLIC Automatic Control System that is used exclusively in the Jamestown plant. When desired, manual operation of the entire boiler system can be made from this location. Panel in the center houses master gauges and other coordinating equipment while panels on either side contain gauges, meters and controls for boilers. REPUBLIC Positioners at left of each panel vary rate of coal feed to pulverizers.

REPUBLIC Regulators and Flow Transmitters are used in the two-element feedwater control system. Rate of feedwater flow to the boiler is changed immediately with a change of either steam flow or feedwater drum level.



Savings are Automatic

At the Jamestown, New York, Municipal Light Plant, two 150,000 lb. per hr. boilers rated at 900 psig. and 900° F.T.T. supply steam to a 20,000 kw turbine. Steam at 275 psig. and 600° F.T.T. is also supplied through a pressure reducing and desuperheater station to an adjoining older plant.

For maximum efficiency and performance, the entire plant is under automatic control. Steam pressure at the turbine is maintained constant and combustion is held at maximum efficiency for steam loads varying from 40,000 lb. per hr. to 165,000 lb. per hr. Both the Automatic Combustion Control System and the pressure reducing and desuperheater station were furnished by REPUBLIC FLOW METERS CO.

ONE OF MANY

This is but one of many power plants that rely on REPUBLIC Instruments and Controls. For more than 37 years, REPUBLIC has specialized in the design and manufacture of automatic control systems for all sizes of power generating stations. REPUBLIC Controls are available for all types of boilers and auxiliary equipment, all kinds of fuel firing (both for single or multiple fuels) and for all load fluctuations. When you specify REPUBLIC Controls, you get the benefit of this complete line of equipment and the services of an experienced engineering staff who know how to put that equipment to use to give you the control system that best meets your requirements.

For complete information about REPUBLIC Automatic Control Systems, send for Data Book S-21 or contact our field engineer nearest you. There's no cost or obligation.

REPUBLIC FLOW METERS CO. ● 2240 DIVERSEY PARKWAY • CHICAGO 47, ILLINOIS

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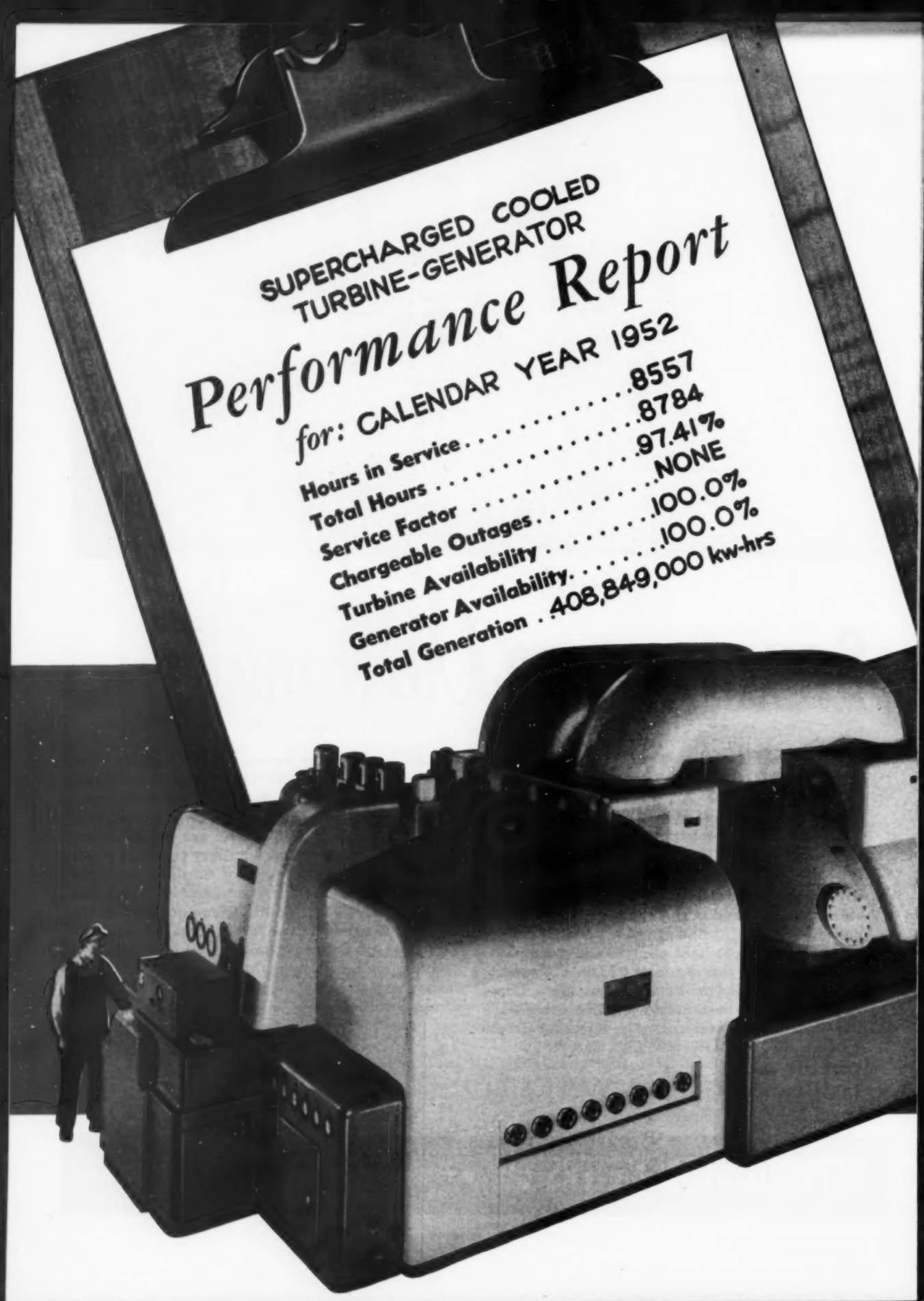

SUPERCHARGED COOLED
TURBINE-GENERATOR
Performance Report
for: CALENDAR YEAR 1952
Hours in Service 8557
Total Hours 8784
Service Factor 97.41%
Chargeable Outages . . . . . NONE
Turbine Availability 100.0%
Generator Availability 100.0%
Total Generation . . 408,849,000 kw-hrs

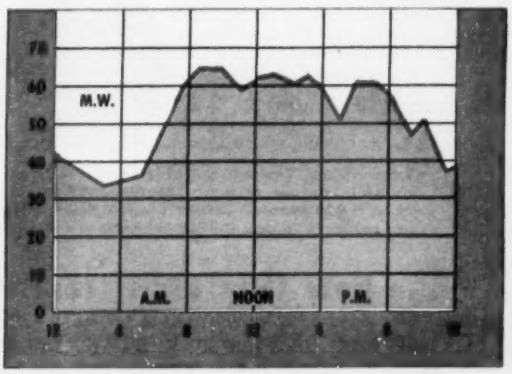
Availability for Duty: 100.0%!

Supercharged Hydrogen Cooling — the greatest advance *ever* made in turbine generator design — has proved itself brilliantly in its first full year's commercial operation!

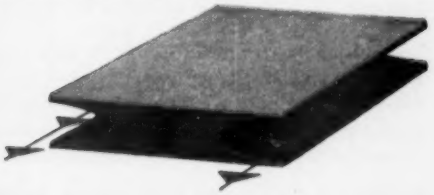
At left is the calendar year 1952 Performance Report on the Allis-Chalmers 60,000 kw steam turbine generator unit at the Edgewater station, Sheboygan, Wisconsin Power and Light Company. Both turbine and generator Availability were 100.0%, with on-the-line Service Factor over the entire year being 97.41%.

Cooling by driving hydrogen at high velocity directly *through* the conductors — supercharging — was first developed and applied by Allis-Chalmers. Supercharging has already permitted increase in generator rating of more than 70% over ordinary hydrogen cooling, with even greater gains forthcoming.

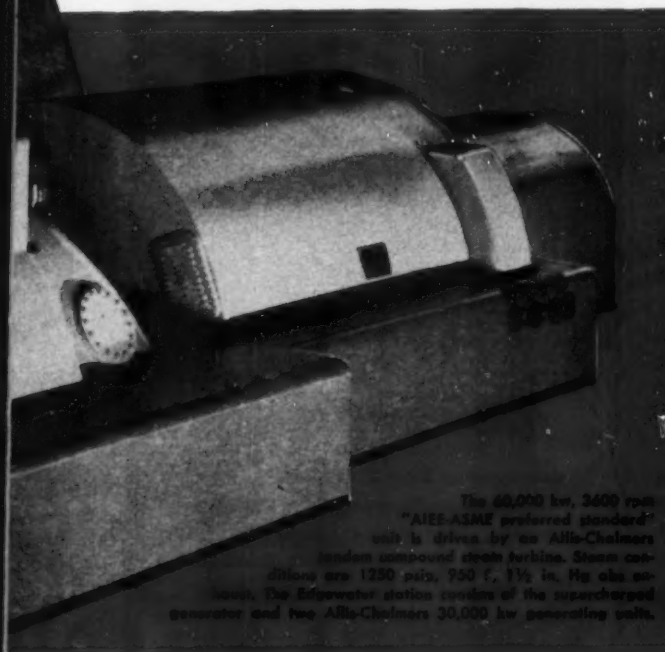
You get the real design advances *first* from Allis-Chalmers, builder of the world's widest range of power plant equipment. When planning a steam-electric power plant, your task will be simpler and results better if you deal with Allis-Chalmers. For complete literature on all products, call your nearest A-C office or write to Allis-Chalmers, Milwaukee 1, Wisconsin. A-3981



Typical daily load cycle of the Sheboygan supercharged unit. It experiences wide load fluctuations because it operates in parallel with base load hydro power. Supercharged units are suited for even this strenuous duty because of high part load efficiency and shorter, more thermally stable construction.



Cross sectional view, showing two turns of typical supercharged conductor construction. The cooling gas is in intimate contact with the copper, removing the heat right where it *originates*. The heat does *not* have to migrate through insulation and surrounding metal to reach vent ducts in the rotor teeth or body.



The 60,000 kw, 3600 rpm "AIEE-ASME preferred standard" unit is driven by an Allis-Chalmers tandem compound steam turbine. Steam conditions are 1250 psig, 950° F, 1½ in. Hg abs exhaust. The Edgewater station consists of the supercharged generator and two Allis-Chalmers 30,000 kw generating units.

ALLIS-CHALMERS

FIRST with Supercharged Hydrogen Cooling!

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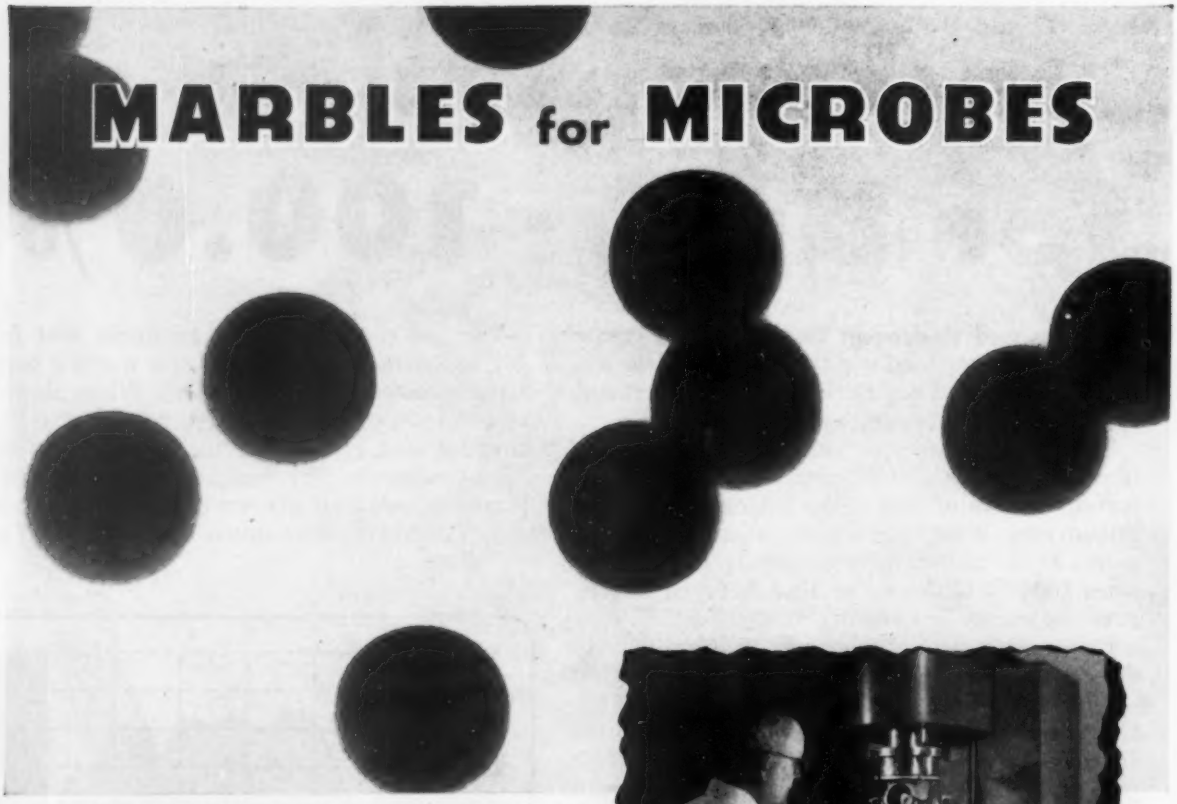
MARBLES for MICROBES



Above—100,000X enlargement of latex spheres used to calibrate electron microscope in Nalco Laboratories. Actual diameter of spheres is 0.25 microns—.00000975 inches! *Right*—Inserting specimen holder in vacuum chamber of Nalco electron microscope.

. . . How they assist research toward better Water Treatment

PERHAPS even too small to make good marbles for microbes, these tiny spheres help Nalco Scientists in their investigations of the microscopic realms of matter only recently made visible to the human eye by the electron microscope.

Use of the electron microscope in water treatment research is significant because it typifies the continuing efforts of the entire Nalco organization to keep the Nalco System representative of the first and best in all phases of modern industrial water treatment.

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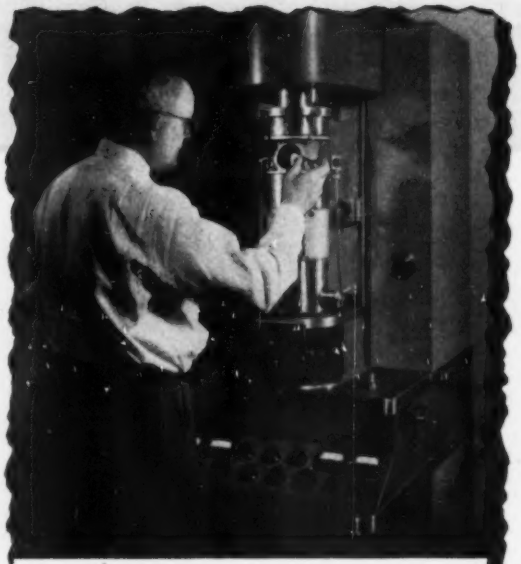

Nalco WATER TECHS

New reprint of A.S.M.E. Paper No. 52-A-30: *Experimental Studies of Boiler Tube Metal Temperatures: Effect of Heat Transfer Rate and Deposit Thickness*, gives technical data on high-heat-transfer-rate effects (140,000 to 300,000 Btu/sq. ft./hr.) at pressures from 250 to 2500 p.s.i. 16 pages, with tables and diagrams. Author: C. Jacklin, Director, Engineering Research, National Aluminate Corporation.

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Helpful Bulletins

THE ANSWERS to many of your operating and maintenance problems are found in these new and recently revised catalogs and bulletins. Circle item numbers of all catalogs wanted on the postage-free card below, detach and mail

VALVES, PIPING AND ACCESSORIES

101 Cast Steel Valves — Now available is a 56-pp catalog covering manufacturer's cast steel valves. Includes information on globe, angle and check valves in 300, 600, 900 and 1500 lb pressure classes. Parabolic disk valves for hand or motor control of volume are also described. In addition to standard information on construction features, dimensions and weights, the booklet contains complete data on material specifications, preparation of welding ends, flange facings, pressure-temperature ratings. Edward Valves, Inc.

102 Plastic Pipe — Here's a 16-pp brochure containing all pertinent information on four types of plastic pipe: flexible, semi-rigid, rigid high impact, and rigid polyvinyl chloride pipe. Detailed tables give chemical and physical characteristics of each type. Also included are advantages of using plastic pipe and directions on how to install and join it. Plastic Products Div., Triangle Conduit and Cable Co., Inc.

103 Uses of Purifiers — Eight-pp Bulletin 700 titled "End Dirt and Moisture Problems the Hi-eF Way" describes uses of purifiers (mechanical separators) in many industries as well as in steam generation and distribution systems. Cutaway views show installation of purifiers in 14 applications. The V. D. Anderson Co.

104 Answer Sheets on Plastic Pipe — Two illustrated leaflets present answers to 22 frequently asked questions about manufacturer's flexible and rigid plastic pipe. They tell what it is, how it is installed, how prices compare with those of metallic pipe and applications for which it is recommended. Also cover installation precautions, use as a temporary line, effects of freezing. Carlon Products Corp.

105 Hydraulic Conversion Factor Table — Although detailed information is available on friction, velocity and friction head for fluids in standard steel and cast iron pipes, there is little such data on plastic lined, plastic, and light wall steel pipes. This table was prepared to make such information available to those concerned with flow in other than standard steel pipes. The Permutit Co.

INSTRUMENTS AND CONTROLS

106 Recorders, Controllers — Catalog 1550, 24 pp, describes and gives details on measurement and control of pH, Redox and conductivity. Includes easy-to-understand theory behind electro-chemical measurement, and gives up-to-date information on recorders, controllers, amplifiers and electrodes. Also contains information on where and how to use automatic pH, Redox and conductivity measuring and controlling equipment. Brown Instruments Div., Minneapolis-Honeywell Regulator Co.

107 Pneumatic Positioning Operator — An operator for high speed positioning and regulating of heavy equipment is described in Bulletin S-15. Explains and illustrates operation of the high capacity valve and actuating mechanism which enable the operator to overcome starting friction and inertia. Gives clearance dimensions for mounting at almost any angle. Republic Flow Meters Co.

108 Temperature Transmitter — Bulletin A-706 describes the T2T temperature primary element transmitter as a resistance thermometer temperature element designed to operate in conjunction with manufacturer's Autronic controlling and recording system. Illustrated with photos, diagrams. The Swartwout Co.

109 How to Select Regulators — This new 36-pp, illustrated "step selection chart" simplifies choice of proper type and size of pressure regulator, temperature regulator or pump governor to do a specific job. Written in non-technical language and supplemented by steam, gas and water capacity tables, this booklet includes installation suggestions, conversion tables and other helpful data. Foster Engineering Co.

110 Industrial Controls — Complete information on a line of industrial controls is available in 32-pp Catalog F 3941-2. Covers control terminology, thermostats, proportioning pressure switch, humidity controls, types of valve bodies, motor-operated valves, solenoid valves, valve capacities, temperature regulators, control motors, relays, electrical accessories, heating and air conditioning controls. Fully illustrated, includes application information. Barber-Colman Co.

111 Gas Meters — Sixteen-pp Bulletin M-152 describes meters for measuring gases of any type, and in quantities from 4000 to 1,000,000 cu ft. In addition to detailed descriptions and illustrations of the various types of meters, booklet contains a selection table for determining meter required for any load, whether at standard or variable conditions of temperature and pressure. Roots-Connersville Blower.

MAINTENANCE COATINGS

112 Industrial Rust Preventives — Showing how manufacturer's products stop rust throughout industry, this 16-pp general catalog provides 73 color chips and includes directions for surface preparation and application of the various products. Covers primers, short- and long-oil types, machinery and implement finishes, chemical and heat resistant types, sealers, thinning oils, and floor and masonry coatings. Rust-Oleum Corp.

113 How to Combat Corrosion — "Where to Use Coal Tar Protection" is an illustrated 8 pp guide to solution of corrosion problems. Presents practical suggestions and includes information on how

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MARCH, 1953
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POWER ENGINEERING

Please have the manufacturers send me without obligation information or bulletins indicated by the numbers circled below.

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Company Name.....

Company Address.....

City.....State.....
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25 26 27

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101	102	103	104	105	106
107	108	109	110	111	112
113	114	115	116	117	118
119	120	121	122	123	124
125	126	127	128	129	130
131	132	133	134	135	136
137	138	139	140	141	142
143	144	145	146	147	148
149	150	151	152	153	154

Catalog Library

201	202	203	204	205	206	207	208	209	210	211	212
213	214	215	216	217	218	219	220	221	222	223	224
225	226	227	228	229	230	231	232	233	234	235	236
237	238	239	240	241	242	243	244	245	246	247	248
249	250	251	252	253	254	255	256	257	258	259	260
261	262	263	264	265	266	267	268	269	270	271	272
273	274	275	276	277	278	279	280	281	282	283	284
285	286	287	288	289	290	291	292	293	294	295	296
297	298	299	300	301	302	303	304	305	306	307	308

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501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521
522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540	541	542
543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	561	562	563
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and where coal tar protection can be used to best advantage. Offers case histories showing how corrosion problems have been overcome. The Tapecoat Co.

PUMPS, PUMPING

114 How to Solve Pumping Problems — A new printing of this popular 36-pp booklet makes it again available to power engineers. Filled with helpful technical information, explains design and operation of rotary gear pumps and discusses factors of pumping problems, covering some sample ones in detail. Illustrated; provides friction loss and conversion tables, electrical data, viscosities of liquids, pump construction materials for handling various liquids, flow resistance of valves, fittings. Geo. D. Roper Corp.

115 Pump Service Manual — Bulletin 202 is a 20-pp booklet covering the installation, operation and maintenance of manufacturer's reciprocating pumps and providing much general engineering information. Such subjects as suction piping, valves and accessories for proper operation are discussed. Sectional drawings and parts lists are provided, also high and low capacity steam consumption curves, general information on water, properties of steam. Warren Steam Pump Co., Inc.

116 Heavy Duty Rotary Pumps — Sixteen-pp Bulletin W-483-B2, covering both herringbone gear type with capacities to 500 gpm and pressures to 100 psi and sliding-vane type with capacities to 1000 gpm and pressures to 200 psi, is complete with fields of application, coverage charts, mountings and dimensions. Engineering data provided includes a viscosity conversion table, relation of API hydrometer scale to specific gravity, and viscosity-temperature chart for fuel oils. Reciprocating Pump Div., Worthington Corp.

MECHANICAL POWER TRANSMISSION

117 Coupling or Converter? — To promote a better understanding of the use of hydraulic couplings and torque converters, this 32-pp publication tells where couplings or torque converters should be used, and why. It "boils down" engineering jargon on hydraulic transmission of power and furnishes a source of facts in non-technical terminology. Covers meaning and characteristics of torque and effect on both driving and driven equipment. Twin Disc Clutch Co.

118 All-Steel Pillow Blocks — In Bulletin A-620, 8 pp, colorful illustrations show features of the new all-steel Dodge-Timken pillow block. Technical information of value in determining whether this new pillow block will solve a particular problem is provided, along with selection information helpful in arriving at the proper size for any application. Data covers pillow blocks in sizes from $2\frac{15}{16}$ to 10 in. Dodge Mfg. Corp.

119 Helical Gear Drives — The advantages, fields of application and correct selection of helical gear drives are discussed in 16-pp Book 2451. Full-page cross-sectional views show design and construction features of both double and triple reduction types, and installation photos are provided, too. Selection factors are described in detail; horsepower ratings for all drives, in all ratios, for input speeds, are shown in tabular form. Link-Belt Co.

120 Speed Reducers — Shaft-mounted speed-reduction units are illustrated and described in this 20-pp catalog. Gives complete information on dimensions of units, where and how they're used and how installed. Includes instructions on how to select proper size drive. Cutaway and phantom drawings illustrate construction details. The American Pulley Co.

121 Simplified Data on V-Belts — Form 3787 is an 8-pp catalog on V-belts for industrial use. Features simplified conversion tables for determining more quickly and easily which of company's belts is the correct one to replace belts of other manufacturers. Prices, dimensions, weights given, also construction details. Thermoid Co.

122 Why Fully Crowned Teeth — Seven major engineering advantages of fully crowned teeth in gear type flexible couplings, are described in Bulletin 1052. Applications of Amerigear couplings for the solution of power transmission problems such as excessive offset or angular misalignment, space limitations, high speeds and torque loads, are described. American Flexible Coupling Co.

ELECTRICAL

123 Totally-Enclosed Motors — Eight-pp Form 1784, illustrated in full color, presents a line of totally enclosed motors, including types for both hazardous and non-hazardous locations. Design details of the motors are shown in a large cutaway drawing, and special construction features are pictured. Includes application information on both explosion-proof and non-explosion-proof motors in this group. U. S. Electrical Motors, Inc.

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124 Power Distribution Practices — The 28-pp "Industrial Power Distribution Idea Book" (Bulletin GEA-5900) is a guide on electric power distribution practices in large and small plants. Covers utility distribution practices; methods of buying electric power; what to do when a choice of primary voltages is available; application of primary switches and circuit breakers; types and arrangements of primary cables; and types of load-center distribution systems. Also discusses use of branch feeder switches, starters, and fuses, grounding of systems, how to calculate interrupting capacity, and other subjects. General Electric Co.

(Continued on page 129)

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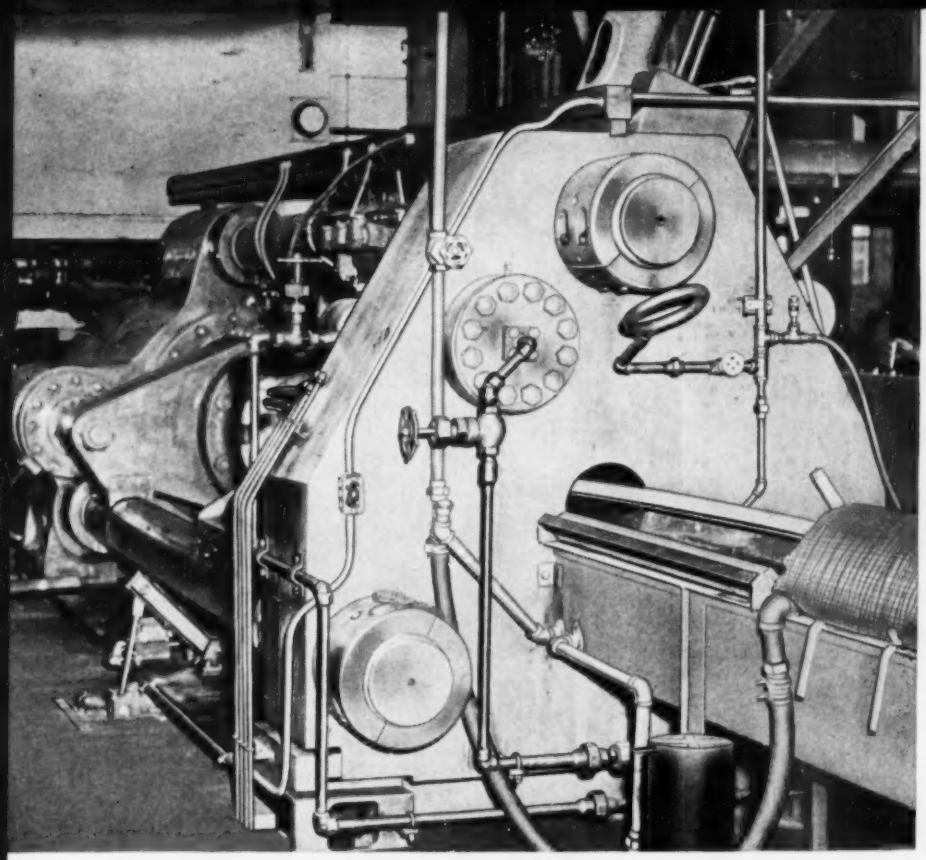

Puts squeeze on hydraulic press maintenance...

• Shown above is the 1250-ton hydraulic press used by the Light Metals Corporation of Grand Rapids, Michigan, for extruding variously shaped sections of aluminum. When this press was installed recently, officials gave the important hydraulic oil job to STANOIL Industrial Oil. They based that decision on their own experience with this outstanding oil.

That experience covered over four years' use of STANOIL in the hydraulic system of a 315-ton extrusion press. STANOIL has served continuously in this press without being changed or removed for oil maintenance. The hydraulic oil system has never been cleaned and has remained entirely free from deposits and varnish. Hydraulic operation has been efficient at all times.

The experience of the Light Metals Corporation is your assurance of STANOIL's ability to reduce hydraulic system maintenance to a minimum in your plant. This versatile oil will provide clean, dependable lubrication for such a variety of equipment as air compressors, reduction gears, and electric motors. The Standard Oil lubrication specialists will help you make the most effective use of STANOIL. Phone him at your local Standard Oil (Indiana) office. Or write, Standard Oil Company, 910 S. Michigan Ave., Chicago 80, Ill.

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What's YOUR problem?

D. R. Clay, of Standard Oil's Grand Rapids, Michigan, office, is the lubrication specialist who has helped Light Metals Corporation keep maintenance of hydraulic units at a minimum through use of STANOIL Industrial Oil.

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Take advantage of the service offered by the lubrication specialist nearest your plant. You can contact him easily by phoning your local Standard Oil Company (Indiana) office. With his help, find how many different oils in your plant can be replaced by STANOIL Industrial Oil on such applications as:

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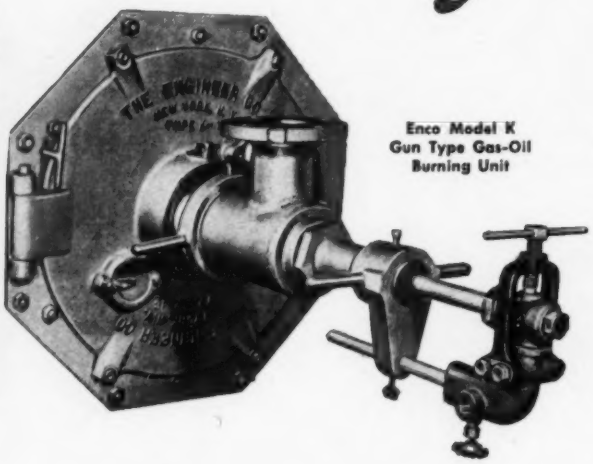

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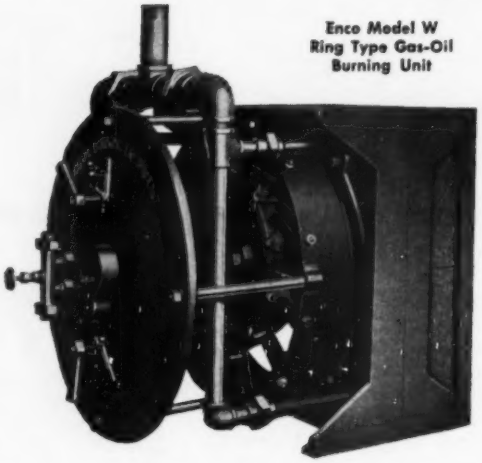
Burning Unit

These specially designed oil and gas burner units fit your needs . . . even when your operating conditions keep changing. Enco Oil and Gas Burner Units offer money-saving flexibility on three important counts. (1) They are designed for use with either oil or gas — or both . (2) They assure completely uniform combustion and greater fuel economy though steam demands swing sharply. (3) They can be operated by either natural or forced draft.

Even if your old combustion equipment "works", it pays to investigate the fuel-saving economies and full flexibility of these highly efficient units. Enco Burner Units are made in many sizes to suit all capacity requirements. Bulletin on request.



Enco Model W
Ring Type Gas-Oil
Burning Unit

ENCO
INTERCHANGEABLE ATOMIZERS
FOR USE WITH ALL TYPES OF BURNER EQUIPMENT

Wide Range Mechanical—Manual or automatic control. Constant high oil pressure at atomizer insures efficient atomization over entire load range without recirculating or returning oil.

Steam or Air—Wide range. Controlled by manual or automatic pressure regulation.

Standard Range Mechanical — Available in all sizes to suit load and capacity requirements.

Enco Standard Range Mechanical Atomizer Gun

Enco Wide Range Steam Atomizer Gun

Enco Wide Range Mechanical Atomizer Gun

Enco Standard Atomizer Gun Support

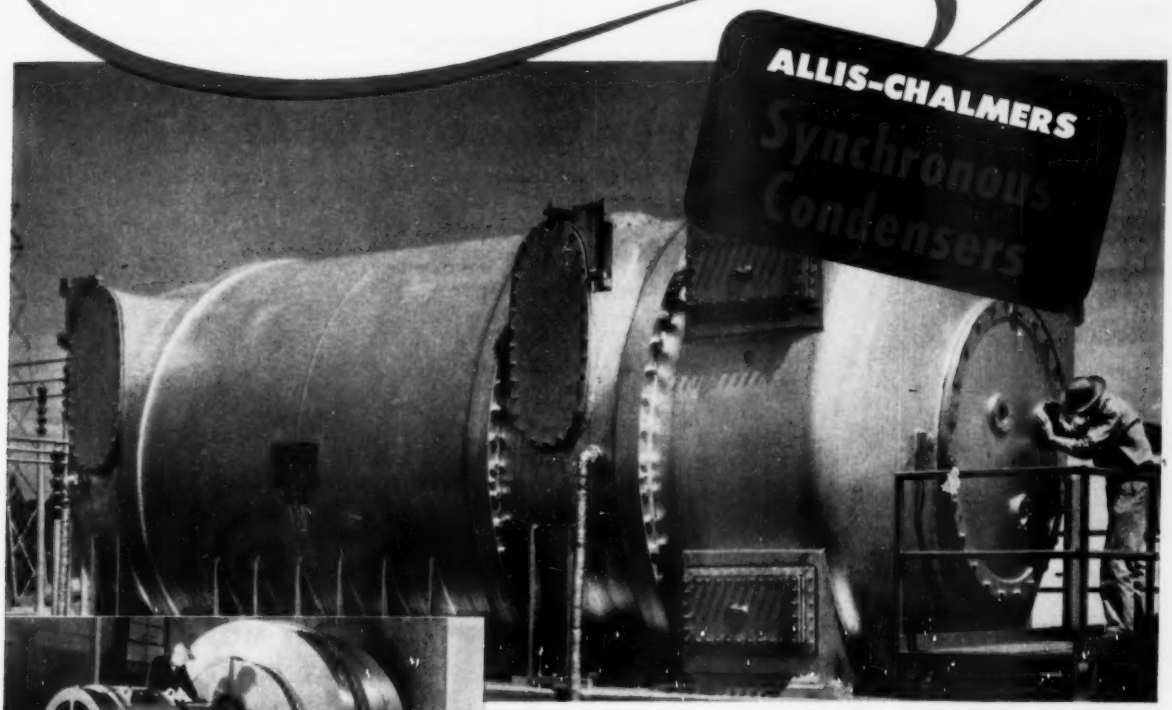
Enco Gas Burning Gun

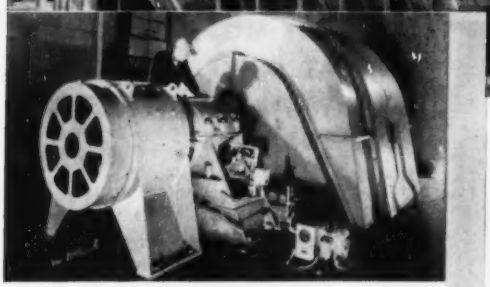
EC-483A

THE ENGINEER COMPANY
75 WEST STREET, NEW YORK 6, N. Y.

For more data circle 522 on Post Card

Better than Rebuilding Transmission Lines





Pacific Coast system uses 50,000-kva hydrogen-cooled condenser (top view), and 20,000-kva air-cooled unit (bottom view).

Besides minimizing losses, hydrogen cooling results in a design suited to outdoor operation. Air-cooled units can also be built for outdoor use, and for industrial power-factor-correction applications.

Regulex amplifier control, which acts as both regulator and pilot exciter, is available for all synchronous condenser ratings.

Regulex is an Allis-Chalmers trademark.

FOR WIDESPREAD power systems, synchronous condensers can frequently be used in place of added or larger transmission lines. This is possible because, by supplying reactive kva, they assure efficient use of power lines.

But condensers can do more than just cut conductor requirements. They also provide voltage regulation on a wholesale scale, and furnish rotating inertia for improved system stability.

Custom-engineered to fill system requirements and to fit installation conditions, Allis-Chalmers synchronous condensers can help you hold down transmission costs. For more information on units for utility or industrial applications, call in your A-C representative, or write for Bulletin 05B7285. Allis-Chalmers, Milwaukee 1, Wisconsin.

A-3960

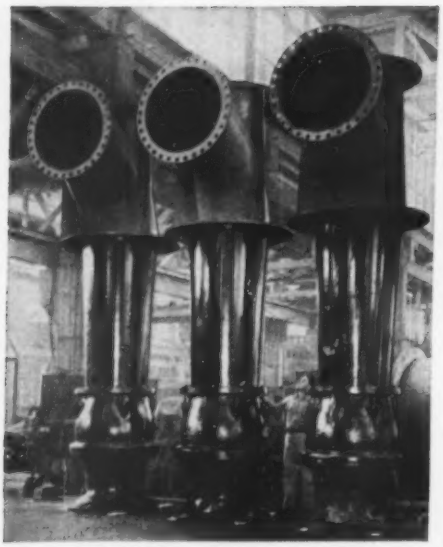
ALLIS-CHALMERS

For more data circle 523 on Post Card

NOTES

for the engineer's note book

...ON
WHEELER-ECONOMY
POWER PLANT
EQUIPMENT



INCREASE OPERATING DEPENDABILITY WITH WHEELER-ECONOMY PUMPS

Wheeler-Economy Pumps Designed Particularly for Power Plant Application Include:

CIRCULATORS

Mixed Flow, Vertical Wet Pit, Standard and "Pull-Out" Types
Mixed Flow Volute, Dry Pit Type
Horizontal Double Suction

CONDENSATE PUMPS

Multi-Stage Horizontally Split Case
Vertical Barrel Type

36" mixed flow condenser cooling water circulating pumps (illustrated) ready for day-in day-out 24-hour service. These circulators have a capacity of 28,000 GPM at 45' head. Driven by 400 HP motors at 585 RPM. Circulators are offered in standard sizes from 1000 GPM to 100,000 GPM and may be furnished on special order for capacities up to 200,000 GPM.

Wheeler-Economy Pumps for General Service Power Plant Operation Include:

Single Stage High Head Double Suction; Multi-Stage Horizontally and Vertically Split Case; Process; Sump; Heating and Fire Service.

BE SURE OF PEAK PERFORMANCE WITH C. H. WHEELER CUSTOM-BUILT CONDENSERS

The thinking of C. H. Wheeler's experienced engineers is not confined to any standard or special type of condenser. They study all the conditions surrounding your requirements—such factors as source, quantity and quality of water supply, etc. The C. H. Wheeler Steam Condenser they subsequently recommend and design for you is, therefore, custom-built for every contingency that might arise. Initial cost is soon paid for and you enjoy the peace of mind that goes with sustained peak performance. Write for bulletin, "Self-Cleaning Steam Condensers with Reverse Flow."

GET MORE EFFICIENCY AT LOWER COST WITH C. H. WHEELER TUBEJETS

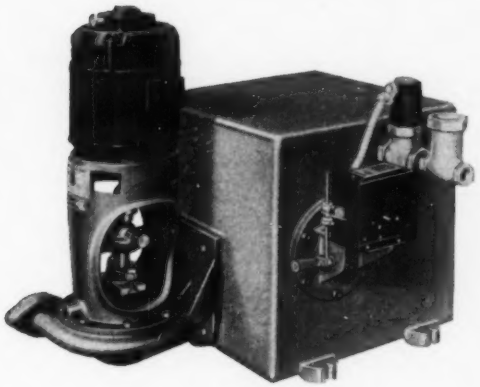
The C. H. Wheeler Manufacturing Company has been foremost in the development of steam jet ejectors, winning engineering awards and world-wide distinction in this field. The C. H. Wheeler Tubejet is a highly reliable vacuum pump. It is easy to install and maintenance costs are low. Long life is assured because the Tubejet has no moving parts. Tubejets are easily arranged in a variety of combinations of single or multi-stage units with inter- and after-condensers to meet all conditions. Write for CATALOG #1462.

C. H. WHEELER *of Philadelphia*

C. H. WHEELER MANUFACTURING CO., 19TH AND LEHIGH, PHILADELPHIA 32, PA.

Steam Condensers • Centrifugal, Axial and Mixed Flow Pumps • Steam Jet Ejectors • Cooling Towers • Vacuum Refrigeration
High Vacuum Process Equipment • Micro-Particle Reduction Mills • Marine Condensers and Ejectors • Deck Machinery

. . . ON
WHEELER-ECONOMY
HEATING PUMPS



SAVE COSTS IN HOT WATER OR STEAM HEATING

HOT WATER—Wheeler-Economy Hot Water Circulating Pumps can be furnished in a large range of types and capacities for economical, efficient use in panel, base board, radiant and all hot water heating systems.

STEAM—For steam heating systems, specify and use Wheeler-Economy Vacuum Pumps and Return Condensation Pumps to obtain top quality performance and reliability. You can count on an open system, free of condensate, at all times.

With Wheeler-Economy Heating Pumps on the job, savings in fuel, efficient BTU delivery and low maintenance pay you important dividends season after season. Our engineers and distributors will be glad to help you on pump specifications. Write for Bulletins on the extensive Wheeler-Economy Heating Pump line and location of nearest distributor.

(Note to Distributors: Some choice territories are still open.)

WHEELER-ECONOMY PUMPS

Division of C. H. Wheeler Mfg. Co.
Philadelphia 32, Pa.

. . . ON Klipfel
FLOAT VALVES

Klipfel WORRY-PROOFS YOUR LIQUID LEVEL CONTROL PROBLEMS

In many cases, you can save money by installing a good mechanical Klipfel Float Valve instead of an intricate, instrumentated controller. Your Klipfel Engineer or distributor can recommend Float Valves that literally "worry-proof" your liquid level control problems. To meet all requirements—pressure, temperature, type of fluid and closure—Klipfel Float and Lever Valves are made in 17 standard styles with a good range of sizes in each style. You can get a Klipfel Float and Lever Valve as small as ⅜" and as large as 12". Either direct acting or pilot control, and single or double seated types offer additional flexibility to meet any set of conditions.

Many thousands of installations—large and small—in water and chemical services—have proved the quality of Klipfel design and workmanship over the past 40 years. Write for BULLETIN #349 which contains really useable information on the selection of float and lever valves.

Klipfel VALVES INCORPORATED

HAMILTON, OHIO

For more data circle 524 on Post Card

Equipment News

SUMMARIZED HERE are new products and improved ones . . . recent developments of leading manufacturers who will gladly supply further information at no cost. You may use the no-obligation, postage-free cards on pages 36 and 129 for your request. Just circle the numbers of the items you'd like to know more about

1—PIPE HANGERS

Constant support, for high temperature process and steam lines

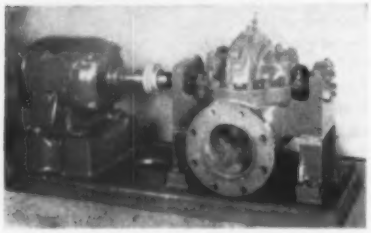
Constant support that is mathematically perfect for all positions of travel for high temperature piping is said to be supplied by the new Model R Constant Support Pipe Hangers. A feature of their design is intended to permit 10 per cent increase or decrease in their load by field adjustment of a single bolt, without impairing their constancy. The new design results in hangers which are smaller in size for the loads carried, company says, and so less head room is required. The hangers can be bolted to the building structure and the frames are drilled for either single- or double-rod suspension. Three frame sizes provide maximum travels of 4, 8 and 12 in., for loads from 48 to 9304 lb.

According to manufacturer, the hangers are non-resonant and in combination with the use of anti-friction needle bearings, friction has been reduced to a minimum; also, the new design provides favorably small ratios between spring force and supported load to minimize bearing stress. Hangers are calibrated before shipment to support exact load specified, and a load scale is provided for field adjustments of at least ±10 per cent. Grinnell Co., Inc.

2—CENTRIFUGAL PUMPS

Single stage, double-suction type; offer design improvements

Standard features on all pumps in the new Fig. 3405 Series include renewable stuffing box bushings, sealed bearing housings, cowl-type glands suitable for use with quenching liquids, stainless steel impeller keys, Teflon water seal rings, die-formed stuffing box packing and corrosion-resistant gland bolts.



Compactness is announced as an outstanding advantage. Bearing spans have been kept to the shortest practical distance to save over-all length — in some models as much as 50 per cent.

Pump casings are horizontally split, and removal of upper half permits inspection and removal of entire rotating element without disturbing suction and discharge piping, or pump and driver alignment.

In the new line there are three different assemblies of shafts and rotating parts. However, thanks to the wide interchangeability of parts in each assembly, it is possible to provide 19 different pump sizes in the three groups. And a locking design of shaft sleeves makes it possible to change the direction of impeller rotation easily, company points out, making 38 actual pump combinations. Mounting dimensions of all pumps within each group are identical.

The pumps can be supplied with electric motor, belt or steam turbine drives, if desired. Capacities range from 200 to 6400 gpm, with heads to 260 ft. Fig. 3405 Pumps are described in Bulletin 721.6. Goulds Pumps, Inc.

3—TEMPERATURE CONTROL

Operates on the principle of differential expansion of solids

Suggested for heating and air conditioning and other controlling applications between the limits of −300 and 300 F, this smaller-size differential expansion control includes such features as snap-action electrical contacts, cast aluminum housing, easy temperature adjustability and close operating differentials.

As in company's other controls, the temperature sensing element consists of a high expanding outer tube and a low expanding inner member. The relative motions of these, caused by temperature changes, is multiplied by a lever which actuates a Micro Switch. A dial graduated 1 to 10, together with an adjusting screw with pointer and a locking set screw, are provided to changing the temperature settings.

As long a tube as is practicable is used in the heated or cooled space. Standard tube lengths are 5, 10 and 15 in., with the 10-in. length recommended for most applications. Standard tube diameters available are ⅜ in. and ½ in. OD. Illustrated data sheet is available. Burling Instrument Co.

4—POSITIONING UNIT

For accurate positioning of cylinder-operated devices

The Poweractor Positioner, for measurement and control of industrial process variables, operates from a standard 3–15 psi pneumatic controller signal, applying a high pressure, pneumatic differential across a cylinder piston sufficient to produce the position demanded by the controller. It is designed especially for use with company's Stabiload Cylinder to position equipment requiring long stroke and power, such as large size control valves, dampers, variable speed drives, through pneumatic cylinder (or springless diaphragm) operating mechanisms.

The positioner is a force balance type instrument, connected to the cylinder piston rod through a bracket and spring assembly. Changes in the controller signal produce a corresponding position change of piston, and the positioner automatically returns to a null balanced condition. Capable of handling up to 150 psig air supply, depending on cylinder rating, and delivering, for example, 12 scfm air flow with a 50 psig supply, the unit is designed to respond to a change in signal pressure of ¼ of 1 per cent of range. Direction of piston movement with respect to a signal pressure may be reversed by inverting the positioner. Component parts are enclosed in a weatherproof case. The Foxboro Co.

5—TUBE FITTINGS

Are made available in fractional sizes for holding thermocouples

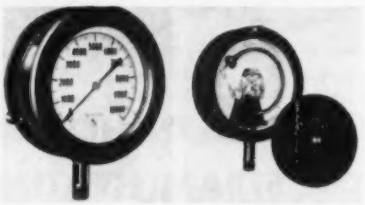
These standard Swagelok Connectors are bored completely through at one diameter. Thermocouples or dip tubes are easily handled with them, it is stated,

and they can be furnished in a variety of sizes from ⅛ in. up in brass, aluminum, steel, stainless steel and Monel. (In an emergency, regular Swagelok Connectors can be bored completely through to the required diameter in the plant shop to accommodate a thermocouple.) Catalog on full line of fittings is available. Crawford Fitting Co.

6—PRESSURE GAGE

Offers protection, easy access to movement and tube assembly

In the Ashcroft Maxisafe Duragauge, an integrally cast solid wall separates dial from gage movement and tube. A double spring-mounted safety release plate covers the entire back of the case. The plate permits the discharge of the



pressure media away from the viewer. Teflon coated to prevent being painted closed or otherwise adhering to the gasket, the safety release plate fits tightly on a rubber gasket and is held in place by a small knurled knob. Less than ½ psi pressure forces open the safety release plate, it is noted.

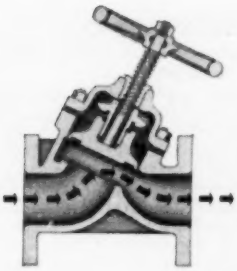
Pressure ranges include 15 psi or vacuum minimum to 100,000 psi maximum. Compound and retard ranges are available. Sizes include 4½, 6 and 8½ in. Manning, Maxwell & Moore, Inc.

7—ELECTRICAL CONDUIT

Made of flexible metal, is designed for use in wet locations

Sealtite Flexible Electrical Conduit Type UA is announced as the first of its kind to gain Underwriters' Laboratories approval for use in wet locations. The tough, extruded synthetic covering

over its flexible metal core protects wiring against moisture, oil, dirt, chemicals and corrosive fumes. The conduit is made of spirally wound, interlocked zinc-plated steel strip with a copper



FOR SAFER CONTROL ---------- OF HARD-TO-HANDLE FLUIDS

CRANE Packless Diaphragm Valves

Now Available in New Materials

WORKING PRESSURES — up to 150 pounds. Water, air, oil, or gas, 180°F. maximum temperature, depending on valve size and materials.

You asked for it—and now Crane gives you this outstanding Diaphragm Valve in a new wide choice of body, disc insert, and diaphragm materials—in unlined or lined patterns. Whichever is specified, Crane design gives you important advantages including—long diaphragm life . . . positive shut-off in case of diaphragm failure . . . less resistance to flow with minimum pressure drop . . . easy operation . . . simplified maintenance at lowest upkeep cost.

Full specification data is in your new Crane 53 Catalog—or ask your Crane Representative.

SCREWED ENDS, UNLINED Sizes ½ to 2 in.
Brass, Cast Iron, Aluminum, or 18-8 Mo body and disc. Furnished with neoprene, Buna N, and natural rubber diaphragm and disc insert.

FLANGED ENDS, UNLINED Sizes ½ to 6 in.
Cast Iron, Aluminum, or 18-8 Mo body and disc. Furnished with neoprene, Buna N, and natural rubber diaphragm and disc insert.

FLANGED ENDS, LINED Sizes 1 to 6 in.
Cast Iron body only. Lined with neoprene or hard natural rubber. Disc coated with neoprene or soft natural rubber.

•

Other body and disc materials, as well as linings, available on special order. Also sliding stem valves for automatic operators of all types.

CRANE VALVES

CRANE CO., *General Offices:* 836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING

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bonding conductor wound spirally in the space between each convolution on the inside of the conduit.

Light and flexible, this conduit can be cut to required lengths and is said to be easily installed in close quarters. Applications of this conduit are suggested to overcome problems of movement, vibration, misalignment — both indoors and outdoors. It is available in long lengths in nominal electrical ID sizes ⅜ to 1¼ in. The American Brass Co.

8—IMPROVED SEALER

For application of active-solvent coatings over asphalt, coal tar

Consistent of synthetic resins and a combination of leafing-type metallic pigments, Sealer P-25M air-dries by evaporation of volatile solvents chosen to have a minimum effect on conventional oil paints, asphalt coatings and similar materials. The sealer acts to form an effective barrier film over surfaces which might otherwise be lifted or wrinkled by active solvents in synthetic resin coatings, it is explained, and it is an excellent anti-staining sealer for use over tar, oils and pitch.

Sealer P-25M is suggested for use wherever asphalt, coal tar and similar coatings are already on the surface; in instances where heavy mastic-type coatings are in use because of their combined insulation and chemical resistance properties, and it is desired to apply chemical-proof top coats in keeping with desired color schemes; as a stock maintenance item to be kept on hand for special painting problems that arise. The sealer is described in Technical Bulletin 023. Prufcoat Laboratories, Inc.

9—EMERGENCY LIGHT

Works automatically to give light when regular power fails

In case of power failure the Model E is designed to give protection and sufficient illumination to carry on operations for many hours. It is primarily intended for use in industrial plants, hospitals, institutions and other places where that extra margin of safety is a must. Without a switch being touched, this lighting unit instantly illuminates the room if regular power fails, manufacturer points out.

The unit is powered by a storage battery built into the portable set. A trickle charger automatically maintains the charge of the battery, and a built-in hydrometer indicates the state of the battery. The unit is plugged into any a-c circuit. Company says the lights are sealed beam, 100 cp, provide up to 10 hr of light. The Model E costs $120.50. General Scientific Equipment Co.

10—CHAIN BREAKING TOOL

Will disconnect roller chain from ¼- up to ¾-in. pitch

The jaws of this tool are of Pearlitic malleable iron, heat treated, the pressing tip is case hardened tool steel. The tool is 5½ in. long. In operation, the roller link of the chain to be disconnected is inserted between the jaws of the tool. The adjustable lever is turned, forcing the pressing tip to push the pin through the pin link plate. Then the process is repeated on the pin at the other end of the same pin link plate, and the chain is disconnected. Boston Gear Works.

11—FLOW METERS

Are small size, variable area type for handling low flow ranges

These new Purge Rotameters are suggested for use where small, low-cost flow meters are needed to indicate and manually control small flows of fluids with good reproducibility but moderate actual measuring accuracy. Typical applications include indication of the flow supply air in bubbler type liquid level measuring installations and the flow of purge fluid in the pipelines connecting orifices, venturi tubes, or nozzles to differential head flow meters.

In these meters the rate of flow of the fluid passing through the meter is indicated by the position of a ball float moving in the tapered glass meter tube vertically installed in the meter. The rate of flow is read in reference to be center of the ball float on a scale mounted alongside of the meter tube. Company points out that these meters must be installed in a vertical position, but they can be installed directly in pipelines, on instrument panels or in instrument cases. Construction details and data on flow ranges, operating pressures and temperatures are offered. Schutte and Koerting Co.

12—OVERLOAD RELAY

Incorporates a sealed silicone time element for improved protection

A new type of overload relay combining extremely high speed operation under dangerous conditions with time delay for starting inrush is announced. Called the Type C Silic-O-Netic Relay, it can be furnished with time delay curves to match characteristics of protected equipment. Since it provides a high speed response point at eight times rating, however, it is said to fulfill the need for protecting hermetically sealed motors, electronic circuits and control systems requiring fast protection at relatively low overload values.

This relay has a hermetically sealed brass tube extending through and beyond the solenoid coil. The tube holds a movable iron core and is filled with a silicone liquid. On starting inrush or small overloads, the magnetic force isn't sufficient to attract the armature. It does, however, draw the core into the field at a rate controlled by the viscosity of the silicones. When the core reaches the pole piece the relay responds, providing delayed response, it is explained; on large overloads, the core is not a factor, relay operation is instantaneous. The relays are insulated for 440 v service with coil ratings from 1 to 100 amp. Complete information is provided in Bulletin 5101. Heinemann Electric Co.

13—INFRARED METER

Is designed for measuring radiant-energy intensities

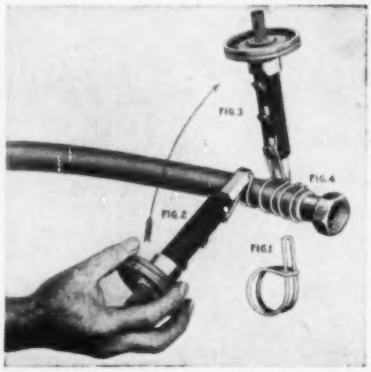
The Type DW-69, for measuring radiant-energy intensities up to 10 w per sq in., is suited for quickly determining the intensity of high range, radiant-energy sources and for studies of infrared radiation effects concerning the absorption and transmission properties of materials.

Company engineers point out that this pocket-size instrument is inexpensive and its operation is simplified because no separate thermopile or other accessory equipment is needed. The radiation receiver is a sensitive thermocouple especially designed for radiation work. Because of a thin thermo element which provides rapid response, the meter need be exposed for only a few seconds when making measurements, it is noted. General Electric Co.

14—HOSE CONNECTION

Band and tool; saves time, work and money in applying couplings

According to manufacturer of this hose connection, no bench or vise is needed to apply the bands and they may be attached anywhere. Comprised of a hose band and hose tool, the tool comes in two sizes to fit all size hoses: the Junior for bands up to ¾ in., and the Senior for



bands 1 in. and over. The bands are made of soft steel wire (also available in brass if required) and are available for hose from ¼- to 3-in. dia. The bands are designed to give a tight, and rust-proof connection, and to be suitable for air, steam, water or oil hoses. The bands make a small joint. Squire-Cogswell Co.

15—BRAIDED PACKING

Is made of Teflon impregnated asbestos and glass fiber

Greater resiliency, resulting in a better seal and longer life, is said to have been imparted to company's white braided asbestos Teflon impregnated packing by a new type of construction which employs a braided or twisted core of the Teflon impregnated glass fiber over which is braided several jackets of asbestos yarn also impregnated with Teflon.

The improvement is reported most pronounced on high speed centrifugal acid pumps where some types of packing have a tendency to heat up due to

a new miniature indicator!

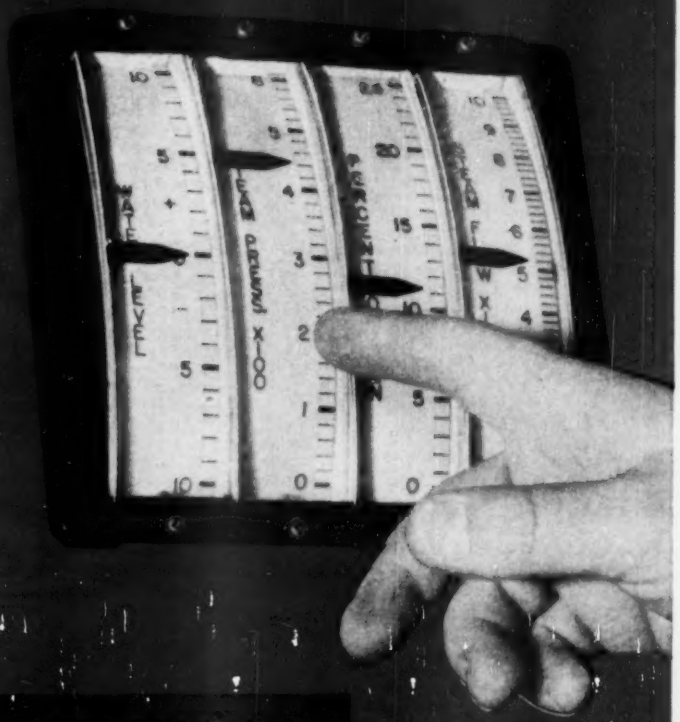
Available with:

MEASURED VARIABLE → AIR-PILOT → COPPER TUBING

PNEUMATIC TRANSMISSION

MEASURED VARIABLE → DIFF. TRANSF. → AMPLI-FIER

ELECTRICAL TRANSMISSION



removable units—interior illumination

easy to read—5 inch scale, no parallax

easy correlation of related functions

easy zero check from the front

HAYS Miniscale Gages

This miniature instrument is especially suited for remote indication of such variables as pressure, draft, flow or level.

The scale is only 5 inches long — easy to read — internally illuminated. Choice of pneumatic or electric transmission.

Also available is the Hays direct reading miniscale gage for indicating *pressures* of fluids (steam, water, gas, oil, etc.) directly.

Gages are arranged for flush or semi-flush mounting. Either a yoke mounting, for as many as 12 units, or a keyhole clamp mounting for individual units can be provided.

Write today for full information on the Hays Miniscale Gages Bulletin 52-1075-223.

Automatic Combustion Control
Boiler Panels • Hays-Penn Flowmeters
Veriflow Meters and Veritrol
Gas Analyzers • Draft Gages
Combustion Test Sets • CO_2 Recorders
Electronic Oxygen Recorders
Electronic Flowmeters
Electronic Feed Water Controls
Miniature Remote Indicators

THE hays CORPORATION

MICHIGAN CITY 7, INDIANA

For more data circle 526 on Post Card

a lack of resiliency. The new construction results in a packing described as almost rubber-like in the larger sizes. Tests are also said to indicate that the new packing offers increased resistance to acid. Flexrock Co.

16—HAND CLEANER

Waterless, for use where water isn't handy or available

Although primarily intended for use where water isn't convenient, this product is water soluble. It rinses thoroughly, company says, leaving hands clean with no oily residue. It is formulated to remove grease, paint, tar, grime and inks. An odorless white stiff jell containing lanolin, it may be wiped off with a towel. It is said to contain no alkali, and not be irritating to the skin. Magnus Chemical Co., Inc.

17—BUCKET ELEVATOR

For loading feeder storage hoppers where floor space is limited

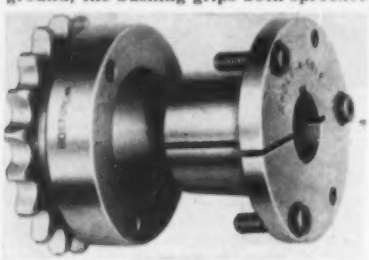
The Model BES-77 Bucket Elevator houses its malleable iron buckets in a 9- by 24-in. steel casing, which is considerably smaller than many elevators. These compact dimensions permit its use in chemical feeder rooms where minimum floor space is a factor. Boot, head and center section are 12-gage mild steel and can be constructed to a height of 25 ft. Each section has flanged ends and dust tight joints.

Driven from a 1½ hp gearhead motor, the feed buckets travel on pintle chain from boot to head at a maximum delivery of 200 cu ft per hour. Dust collectors, bin level switches and other accessories are available for use with this equipment when required. Omega Machine Co.

18—SPLIT TAPERED BUSHING

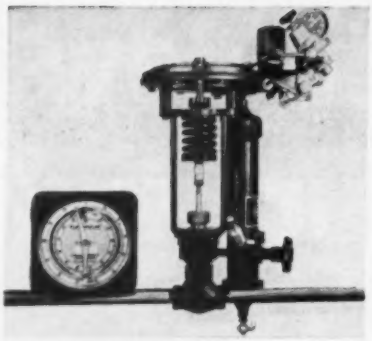
Interchangeable type is designed principally for use with sprockets

The Shold-A-Grip Bushing makes it possible to use the same size sprockets on shafts from ½ to 2½ in. dia in steps of 1/16 in., eliminating need to rebore stock sprockets to fit particular shafts. This bushing is drawn into the tapered hole in the sprocket by tightening cap screws. As both its inner and outer diameter and the bore of the sprocket are ground, the bushing grips both sprocket



and shaft with the equivalent of a press fit — even on undersized shafts, company points out.

The mating Shold-A-Grip Sprockets have a shoulder on the hub, allowing room between teeth and shoulder for chain clearance. Because the bushing is screwed to the shoulder, and because the diameter of the shoulder is not limited by chain clearance, this sprocket can be manufactured with a maximum size bore and minimum number of teeth. The sprockets come in sizes from ½ to 1¼ in. pitch. Form 50M gives detailed data. Boston Gear Works.



19—CONTROL VALVE

For automatic control of boiler blowdown operations

By automatically and accurately taking over the job of regular boiler blowdown, this new intermittent blowdown control valve is expected to effect substantial savings in operating efficiency, labor and maintenance downtime. The valve serves to cause repeated disturbance of boiler water, preventing water crystal growth and formation of the scale and residue that normally build up insulation against the primary fuel. It is described as particularly valuable where feed water supply is badly contaminated.

Permanently attached to the blowdown outlet of the boiler, and equipped with an automatic cycle-timer, this valve assumes complete blowdown control, according to manufacturer; it can be adapted to all types of industrial boilers, and once correctly set requires practically no attention. A descriptive booklet is available. Rice Industries.

20—TUBE FITTINGS

Are designed to permit easier installation, provide good seal

Ermeto Tube Fittings are announced as providing a more positive seal than flared or compression type fittings — yet requiring no flaring, threading, welding, soldering or special preparation. The fitting consists of a sleeve, nut and tapered body. As the nut is tightened, it forces the sleeve forward into the taper of the body. The leading edge of the sleeve contracts, thus forcing the cutting edge to shear a slight groove into the outer surface of the tubing, company explains, providing a leak-proof joint between fitting and tube. The nut pressing on the bevel of the sleeve results in a tight grip.

When fully tightened, the sleeve is bowed slightly at the mid-section, causing it to act as a lock-washer. This locking action maintains constant tension between body and nut, thereby preventing loosening of the nut. Once the fitting has been assembled, the sleeve becomes permanently attached to the tube. Disassembly and reassembly of fitting can be made without loss of sealing quality. The fittings are available in carbon and stainless steels, also in Monel and brass on order. Catalog E-1457 describes these fittings in detail. The Weatherhead Co.

Use post cards on pages 36 and 129 for more information on any of these products

21—NEW FLEXIBLE COUPLINGS

Are designed so as to "crawl into flywheel," and save space

A new modification of this manufacturer's Type C Coupling is described as one which "crawls into the flywheel." Said to be economical in cost, as well as in space required, it is a standard coupling with one hub cut off. Three or more holes are tapped in the remaining flange, by which the coupling is fastened to the center of the flywheel.

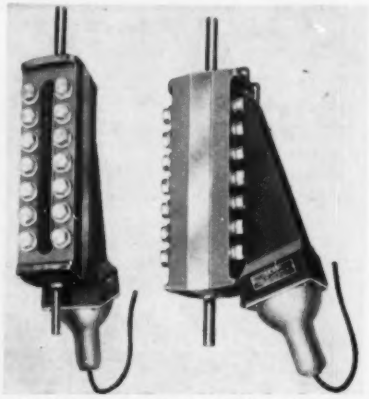
Thus by crawling into the flywheel itself, this coupling saves the space normally taken up by the conventional hub-length, and also affords a cost saving in the elimination of the flange. Complete information on this coupling, including blueprints, is offered. Lovejoy Flexible Coupling Co.

22—ILLUMINATOR

For easier reading of flat glass water level gages in boiler plants

The Yarway Type M Illuminator uses a 100-w sealed-in beam mercury vapor lamp as its source of light. This lamp is said to produce about twice the amount of light for the same power input as an incandescent light, and the greenish blue color of the light emitted to provide better visibility. The over-all effect credited to these factors is a brilliant source of illumination which makes the meniscus at the water lever "shine like a star" over the entire length of visibility.

With these illuminators, water levels are successfully transmitted a distance up to 125 ft, manufacturer reports, and



with the use of a light shield at the gage and suitable ducts, this distance can be increased. The mercury vapor rays are also claimed to penetrate foreign deposits on the mica and to be less affected by extraneous light.

The complete unit consists of the illuminator shown in these two views, plus a small ballast, not shown, which can be conveniently located and plugged into a standard 120-v electrical system. Yarnall-Waring Co.

23—POLE-BRACKET CABLE

For street lighting service, features all-plastic insulation

Voltage rating of this new pole-and-bracket cable is 600 v between conductors; 6000 v from conductor to ground. It is made with two flexible stranded conductors, each insulated with Densheath (PVC); one black and one white, laid parallel, and a black polyethylene jacket. The finished cable is oval shaped. Sizes and other information available. Anaconda Wire & Cable Co.

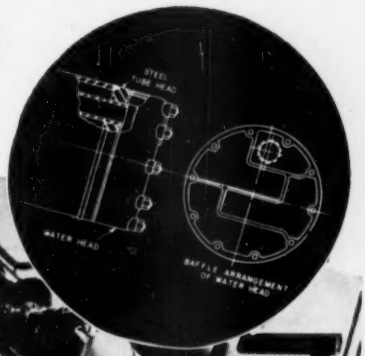
$ave Power and REFRIGERATION COST

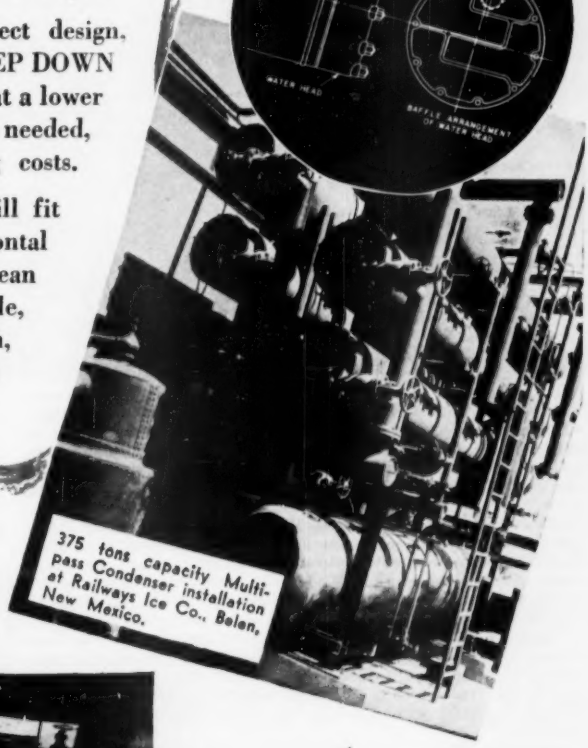
Vogt Condensers, because of their correct design, STEP UP the rate of heat transfer and STEP DOWN head pressures. With the liquid delivered at a lower temperature, smaller compressor capacity is needed, saving in original as well as operating costs.

One of the two basic types illustrated will fit your operations exactly. Install Horizontal Multipass (closed type) for use with clean waters. Where the water is hard, forms scale, contains mud or promotes fungus growth, Vertical Single Pass (film type) which can be cleaned in operation, are recommended.

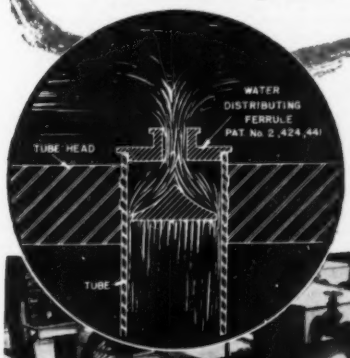
Horizontal Multipass Condensers
(Closed Type)

Water circulated in tubes traverses the length of the unit a number of times as determined by baffles in the heads.



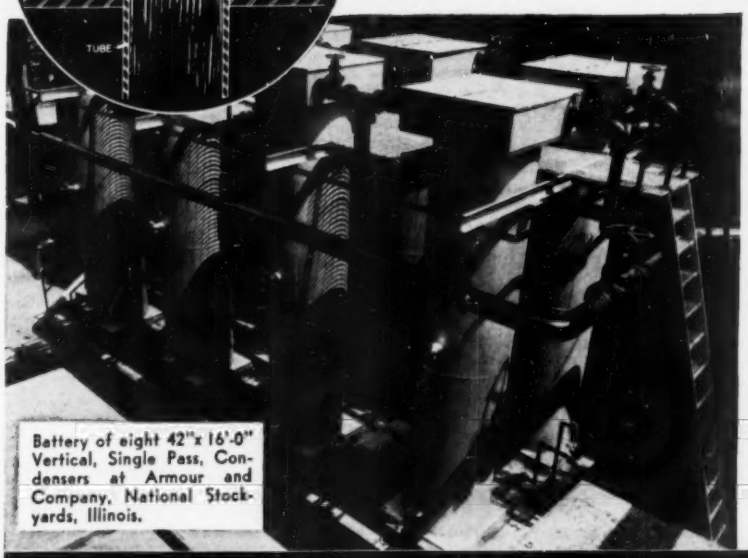


375 tons capacity Multipass Condenser installation at Railways Ice Co., Belen, New Mexico.



Vertical Single Pass Condensers
(Film Type)

Patented ferrules give equal distribution of water to and over the surfaces of all tubes in a unit.



Battery of eight 42"x 16'-0" Vertical, Single Pass, Condensers at Armour and Company, National Stockyards, Illinois.

HORIZONTAL and VERTICAL TYPES SHELL and TUBE CONDENSERS For Every Service

Write For Bulletin RC-1

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Vogt REFRIGERATION CONDENSERS

For more data circle 527 on Post Card

POWER PLANT Construction News

Big Delta, Alaska — United States Engineer Office, Anchorage, Alaska, has tentative plans for new power plant at base at Big Delta, for lighting, power and central-heating service. Bids are expected to be asked during 1953. Cost estimated close to $2,100,000.

Arkadelphia, Ark. — Reynolds Metals Co., Third and Grace Sts., Richmond, Va., plans power house at new aluminum reduction plant at Arkadelphia. It will consist of several large units, equipped for a rating of 110 million lbs. per annum. No official estimate of cost announced — will represent a total investment of several million dollars. Work will proceed at early date.

Anaheim, Calif. — Delco-Remy Division, General Motors Corp., Anderson, Ind., automobile storage batteries, ignition equipment, etc., plans boiler house at new plant at Anaheim, where tract of 90 acres of land has been secured. It will comprise several buildings, equipped for manufacture of storage batteries. Cost reported over $1,000,000. Proposed to begin work early in 1953.

Newark, Calif. — Orangeburg Mfg. Co., Inc., Orangeburg, N. Y., fibre conduits, ducts, pipe, etc., plans boiler house at new branch plant on Central Ave., Newark, where site has been selected. It will consist of several large buildings and is reported to cost over $2,000,000. Austin Co., 618 Grand Ave., Oakland, Calif., engineer-contractor, has prepared plans and will supervise construction.

Denver, Colo. — Public Service Co. of Colorado, 900 15th St., plans expansion in Zuni steam-electric generating station, with installation of new 66,000-kw. turbine-generator and auxiliary equipment. Work will be carried out during 1953. Company now has work in progress on addition to generating plant at Alamosa, to increase output by 10,000-kw., scheduled for completion in 1953. This is part of general expansion program of company, estimated to cost about $14,900,000 during coming year.

Newington, Conn. — Fenn Mfg. Co., 1841 Broad St., Hartford, Conn., special machines, aircraft parts, presses, etc., plans boiler house at new branch plant at Newington, where tract of 50 acres of land has been secured. It will comprise several production buildings for manufacture of aircraft equipment. Cost about $1,200,000. Work will be carried out at once.

Jacksonville, Fla. — A bond issue of $18,000,000 has been voted by city for expansion and improvements in municipal power plant and facilities, with installation of additional generating units, boilers, etc., for large increase in present capacity. Program will be carried out by Municipal Electric Dept., ft. of Laura St.

Chicago, Ill. — Zenith Radio Corp., 6001 Dickens Ave., radio, television and allied equipment, plans new boiler plant for central-heating service, in connection with new addition to factory, totaling over 300,000 sq ft floor space. Proposed to begin work soon. Entire project is reported to cost approximately $3,000,000.

Richmond, Ind. — Municipal Electric Light & Power Dept., plans expansion in municipal power plant for increased capacity. Cost estimated about $750,000. A. E. Beck is plant manager.

Mason City, Iowa. — Allied Mills, Inc., 141 West Jackson Blvd., Chicago, Ill., flour, animal feed, alfalfa, etc., plans boiler plant at new feed mill at Mason City, comprising three main units for mixing and other service. Work will begin soon. Cost reported about $1,000,000.

Ashland, Ky. — Armco Steel Corp., Middletown, Ohio, plans expansion in power plant and facilities in connection with proposed extensions in steel mill at Ashland, for considerable increased capacity. Project is expected to be placed under way early in 1953, and is estimated to cost about $12,000,000.

Baltimore, Md. — Consolidated Gas, Electric Light & Power Co., Lexington Bldg., is arranging fund of about $30,000,000, for extensions and improvements in plants and system during 1953, including generating stations, power substations and other operating facilities.

Halethorpe, Md. — Kaiser Aluminum & Chemical Corp., 1924 Broadway, Oakland, Calif., plans power house at new branch alumina plant at Halethorpe, for manufacture of materials used for production of abrasive, glass and other ceramic products. Main unit will be one-story, 300 x 750 ft. Entire project will cost over $1,500,000. Work will be carried out soon. Giffels & Vallet, Marquette Bldg., Detroit, Mich., are architects and engineers.

Boston, Mass. — State Dept. of Public Health, State House, Boston, plans power house at new chronic disease hospital and nurses home in Forest Hills district, Boston. Plans have been approved and work will begin soon. Cost over $11,500,000.

Saginaw, Mich. — Saginaw Steering Gear Division, General Motors Corp., will build new power house at local plant, to be carried out in conjunction with new addition to plant, about 450,000 sq ft floor space. Entire project is estimated to cost close to $5,000,000. Work will be placed under way at once.

Canton, Ohio. — Ohio Power Co., 301 Cleveland Ave., S. W., has authorized financing in amount of $32,000,000, a considerable part of proceeds to be used for power plant construction, power substations, transmission lines and other operating facilities in 1953.

Columbus, Ohio — Municipal Electric Light Dept., plans expansion in municipal power plant, including construction of new addition, and installation of two new 12,000-kw. turbine-generators, high-pressure boiler and auxiliary equipment. Cost reported about $2,500,000. Proposed to carry out work in 1953.

Columbus, Ohio. — State Dept. of Public Welfare, State Office Bldg., has plans for extensions and improvements in power plant at local State Hospital, including installation of additional equipment. No official estimate of cost announced. Proposed to carry out work soon. Sims, Cornelius & Schooley, 2901 North High St., Columbus, are architects and engineers.

Toledo, Ohio. — Toledo Edison Co., Edison Bldg., will have plans prepared by George W. Saathoff, 60 Wall St., New York, N. Y., consulting engineer, for proposed new steam-electric generating plant, recently announced in these columns. It will have a rated capacity of 125,000-kw., and is estimated to cost close to $25,000,000. Proposed to begin work in 1953.

The Dalles, Ore. — Harvey Machine Co., Inc., 19200 South Western Ave., Torrance, Calif., plans power plant at proposed new aluminum reduction works at The Dalles, where site has been selected. Project will comprise several large units and is reported to cost close to $40,000,000. Application for permission to proceed with program has been made to National Production Administration, Washington, D. C.

Lancaster, Pa. — Aluminum Co. of America, Inc., Gulf Bldg., Pittsburgh, Pa., plans power house at proposed new mill at Lancaster, for fabricating aluminum screw machine products. It will comprise several buildings, totaling 200,000 sq ft floor space, and is reported to cost about $3,000,000. Work is expected to be placed under way early in 1953.

Austin, Tex. — Bd. of Regents, University of Texas, plans expansion in power plant at institution, with installation of additional equipment for increased capacity, as well as distribution. Cost estimated about $1,500,000. Program will be carried out in conjunction with erection of number of new buildings at college, and other miscellaneous work.

Amarillo, Tex. — Southwestern Public Service Co., Amarillo, will expend about $23,400,000 for expansion and improvements in plants and system during 1953, including new generating stations, power substations, transmission lines and other operating facilities.

Dallas, Tex. — Dallas Power & Light Co., 1506 Commerce St., plans new steam-electric generating station in Mountain Creek area, with initial capacity of 165,000 kw. Cost reported about $16,000,000, with power station, transmission lines and other operating facilities.

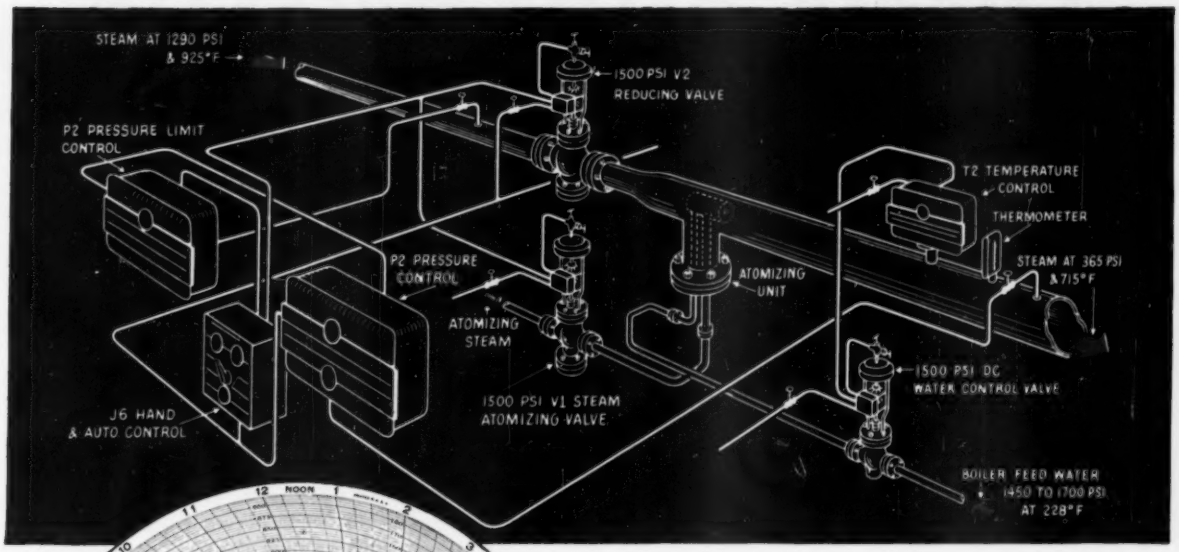
Evadale, Tex. — East Texas Pulp & Paper Co., Houston, Tex., care of Houston Oil Co., of Texas, Petroleum Bldg., Houston, recently organized by officials of latter company, and Time, Inc., 9 Rockefeller Plaza, New York, N. Y., publisher, plans power plant at proposed new pulp and paper mill at Evadale (Jaser County), where site has been selected. It will comprise several large production units, with rated output of 250 tons daily. No official estimate of cost announced — reported over $7,500,000. Proposed to carry out work in 1953.

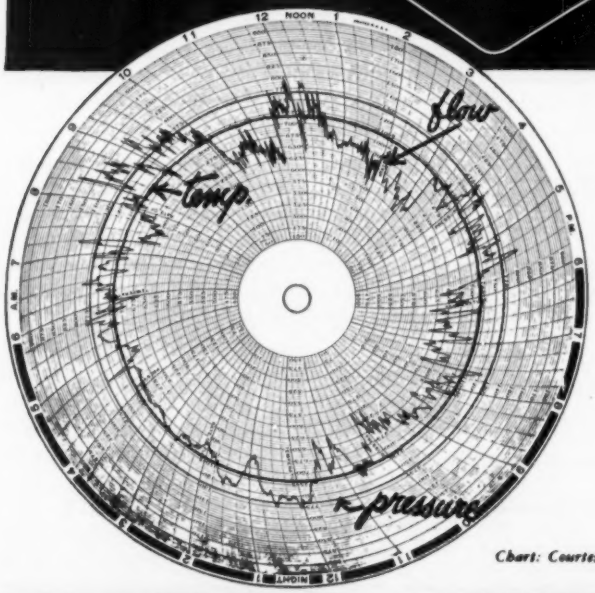
Hite, Utah — Vanadium Corp. of America, Inc., 420 Lexington Ave., New York, N. Y., plans power plant at proposed new uranium mill at Hite (San Juan County). It will consist of several multi-story structures, equipped for large output, to be used by Atomic Energy Commission, Washington, D. C. Cost reported over $2,000,000.

Moundsville, W. Va. — National Aniline Division, Allied Chemical & Dye Corp., 40 Rector St., New York, N. Y., plans power house at new plant unit at Moundsville, to be equipped for manufacture of fumaric and other acids. It will comprise a number of one and multi-story production buildings, equipped for large output. Cost reported approximately $4,500,000. Work will be carried out soon.

Wauwatosa, Wis. — Milwaukee County Institution Dept., Wauwatosa, has authorized plans for new power plant for heating and lighting service on Watertown Plank Rd., near County Hospital for Mental Diseases. Cost reported over $4,000,000 with generator unit, high-pressure boilers and auxiliary equipment. Bids will be asked for in near future. Pfeifer & Schultz, Wesley Temple Bldg., Minneapolis, Minn., are engineers.

Swartwout RDC* controls within ±1 psi and ±3°F even with widely fluctuating load swings


STEAM AT 1290 PSI & 925°F
1500 PSI V2 REDUCING VALVE
P2 PRESSURE LIMIT CONTROL
T2 TEMPERATURE CONTROL
THERMOMETER
P2 PRESSURE CONTROL
ATOMIZING UNIT
STEAM AT 365 PSI & 715°F
ATOMIZING STEAM
1500 PSI DC WATER CONTROL VALVE
J6 HAND & AUTO CONTROL
1500 PSI V1 STEAM ATOMIZING VALVE
BOILER FEED WATER 1450 TO 1700 PSI AT 228°F

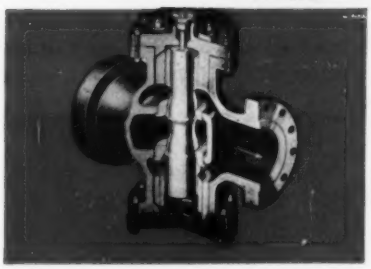


1 Chart shows how Swartwout RDC*—Reducing, Desuperheating and Control System—handles low-pressure turbine load of 65,000 to 165,000 lbs. steam per hour in Des Moines Power Station No. 2 of the Iowa Power and Light Company. It reduces from 1290 to 365 psi and desuperheats from 925° to 715°F. When main reducing valve closes, extremely light loads can be handled by pressure reducing valve supplying atomizing steam. Operation of the system is stable regardless of load change or time lag. Because of the exceptional control obtained by this large station, the Iowa Power and Light Company later purchased an additional small Swartwout RDC unit to supply steam to house turbines.

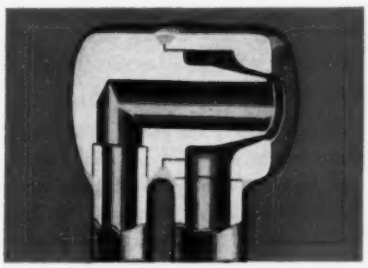
Swartwout

POWER PLANT EQUIPMENT

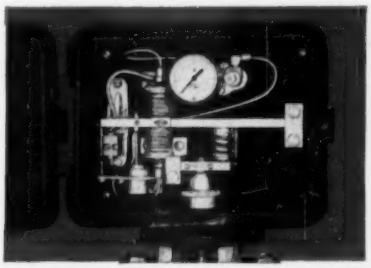
Chart: Courtesy Iowa Power and Light Company



2 Swartwout V-2 Regulating Valve has smooth, nozzle-shaped passages which guide expansion of high-pressure steam to reduced pressure zone without high-velocity impingement or other destructive forces common to conventional valves. Undue noise, turbulence and vibration are eliminated; longer valve life results.



3 Swartwout Steam Atomizing Desuperheater, constructed of stainless steel, has accurately machined passages that give narrow-angle dispersion of cooling water outside of steam atomizing head. There is no impingement of steam or water against walls of unit, no erosion of parts, no need for pipe liners.



4 Swartwout T-2 Control, with metallic temperature element in steam pipe, gives rapid and precise control regardless of magnitude of load or time lag. There are no flapper valves, relays or other delicate elements. Only two simple adjustments are involved; one for temperature, one for response.

SEND FOR BULLETINS S-21-E, S-22-C, S-198 • THE SWARTWOUT COMPANY, 18511 EUCLID AVENUE, CLEVELAND 12, OHIO

For more data circle 528 on Post Card

BRIDGEPORT BRASS COMPANY
CONDENSER AND HEAT EXCHANGER TUBE EDITION
COPPER ALLOY BULLETIN
"Bridgeport" BRASS CO. MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND. — IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL

Effect of Temperature on Condenser Tube Corrosion

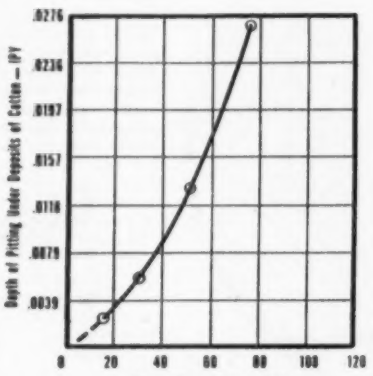
Heat accelerates practically all chemical reactions. Qualitatively, it may be said that a temperature rise of the corroding solution of about 35°F will double the rate of corrosion. The effect of temperature varies with the character of the circulating water, the nature of the corrosive medium, and the condenser or heat exchanger tube alloy involved.

For this reason many plant engineers keep a temperature record of incoming and outgoing condenser waters, because it is realized that a unit operating at too high a temperature will fail prematurely.

The higher temperature of cooling waters during the summer of the year is also one of the factors contributing toward more rapid condenser tube corrosion during this season. Instances have been reported where new condenser tubes installed during the cold winter season have given longer service than new tubes installed during the warm summer. This difference in performance occurs because the type of protective film which forms on a metal in cold water is generally thinner and of a more continuous nature than that which forms in warm water.

In warm and hot waters, the susceptibility towards pitting and dezincification generally increases appreciably. Due to pitting, the useful life of a condenser tube may be considerably shorter than that indicated by the over-all corrosion rate as evaluated by loss in weight or loss in tensile strength. This pitting may be substantially increased by the presence of sulfides in the cooling water especially during the summer season.

In certain waters, the corrosion rate drops off with an increase in temperature because the water deposits a scale. Calcium carbonate forms as a result of the decomposition of calcium bicarbonate at elevated temperatures. If a continuous deposit of calcium carbonate forms, it may protect the underlying metal. However, if breaks occur in this type of impervious scale, pitting is likely to take place on the exposed areas



Effect of temperature on rate of corrosion of Admiralty Brass in 3 per cent sodium chloride solutions.

especially when the water velocity is high.

Unfortunately, the build-up of a thick scale on the inside of a water heating coil, boiler or condenser tube seriously interferes with heat transfer. This loss in heat transfer results in considerably higher temperatures on the metal surfaces facing the hot gases or liquid. The high temperature often leads to more rapid corrosion as well as thermal stressing (bending and buckling) and lowering of the creep strength of the metal (cracking or intergranular failures).

Influence of Temperature on Intergranular Corrosion

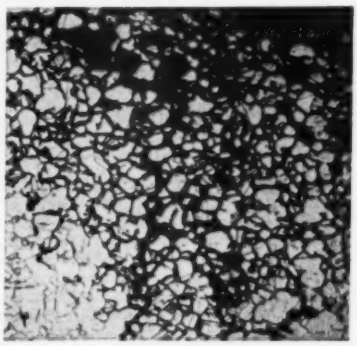
Corrosion sometimes tends to follow the grain boundaries of the metal to a depth of only a few thousandths of an inch which is generally of no serious consequence. However, where intergranular corrosion penetrates the tube wall, it destroys the usefulness of the tube. This condition is most acute in the hottest zone of heat exchangers and condensers when hot corrosive gases are handled.

Intergranular corrosion may also occur on the water side of the tube when the water velocity is low, resulting in a correspondingly high tube wall temperature.

The preventive measure is to maintain a low tube wall temperature — either by increasing the water flow and to remove trash which blocks the tubes. Under these conditions all of the standard copper-base condenser tube alloys give satisfactory service.

However, if a very high water velocity is needed to lower the tube wall temperature, then in order to avoid impingement corrosion, Aluminum Brass, Aluminum Bronze and Cupro Nickel alloys may be needed.

The Bridgeport Corrosion Laboratory will be glad to help you in connection with specifying the alloy which will give you the best service life. Please contact our nearest Bridgeport district office for your condenser and heat exchanger tube requirements. (9497)



Intergranular corrosion. Micrograph mag. 75X.

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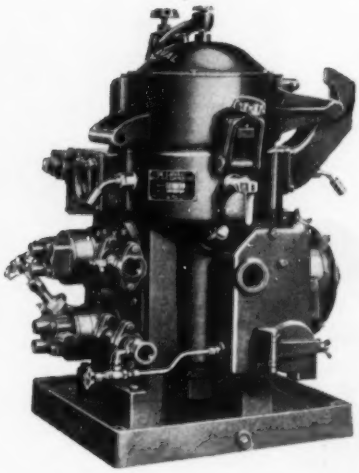
THE TRUE YARDSTICK IS . . . PROTECTION



The cost of a De Laval Oil Purifier is only a fraction of the cost of the turbine or engine that it protects. The comparatively modest investment represented by a De Laval centrifuge is far outweighed by the cost of even **one** serious shutdown. A De Laval is, in truth, inexpensive insurance.

A De Laval Purifier, by means of centrifugal force applied in the most efficient manner, removes from the oil all water, dirt or sludge. It keeps the lubricant both ***clean*** and ***dry***. Purification is complete—an important point—for water can be as serious a source of contamination as dirt.

A De Laval Oil Purifier thus provides assurance that there will never be turbine trouble due to impure lubricating oil. The protection it gives in this respect is ***absolute***.

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Poughkeepsie, New York 427 Randolph St., Chicago 6

DE LAVAL PACIFIC CO., 61 Beale St., San Francisco 5
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FOR MORE DEPENDABLE POWER PRODUCTION

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INTERNATIONAL HARVESTER PICKS YARWAY

SEATLESS TANDEM BLOW-OFF VALVES

International Harvester Company's great McCormick Works at Chicago is another long-time user of Yarway Seatless Blow-Off Valves. Yarways guard each of the four large boilers in the plant.

Good boilers are better boilers with Yarway Blow-Off Valves. Good design, careful engineering and manufacturing, modern metallurgy, dependable service—all combine to make Yarways the standard blow-off valves in more than 15,000 plants.

Yarway engineers, conveniently located near you, are constantly working for better, more profitable steam plant operation. Call a Yarway man for help on your problems.

Yarway Seatless Blow-Off Valve features balanced sliding plunger. *There is no seat to score, wear, clog or leak.* Write for Bulletin B-425 for pressures to 400 psi.; Bulletin B-433 for higher pressures.

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114 Mermaid Ave., Phila. 18, Pa.
BRANCHES IN PRINCIPAL CITIES

YARWAY SERVICE GOES ALL THE WAY . . .

Here and There

With "Condor Juan"

John M. Drabelle recently retired as chief engineer, Iowa Electric Light & Power Co., and is now a private consultant. He is a Fellow ASME, AIEE, also Member Committee on Power Generation, Assn. of Edison Illuminating Companies; Member Prime Movers Committee, Edison Electric Institute. The story on this page tells some of his experiences when he was called on a consulting job down in Chile, South America

John M. Drabelle, M.E., E.E., Consulting Engineer whom Chileans affectionately call "Condor Juan"

IF YOU want a thorough review of how much you know and how much you have forgotten, you should take a trip to South America on a steam power plant trouble-shooting job, as I did. When you are 5000 miles away from home, as I was when I reached Santiago, Chile, my destination, it was soon apparent I was *the expert* and, as you know, an expert is defined as an ordinary guy miles away from home. But first, let's get there.

I left the States at Miami, Florida, flying down via Pan American-Grace Airlines. Leaving Miami at 8 p.m. we arrived in Panama at midnight, Lima, Peru at 7:30 a.m. the next morning, made a stop at Antofagasta, Chile and landed in Santiago at 2:30 in the afternoon. The flight down from Lima was at about 12,000 ft and around five miles off shore. This route is well planned because you have a wonderful view of the Andes Mountains which in many ways make our Rockies look like what the Chileans call ridges. Coming into Santiago you get an excellent view of the highest mountain in the western hemisphere, Aconcagua, which is approximately 23,000 ft high.

Santiago, the capital of the Republic of Chile, is a beautiful city set in a basin surrounded by the Andes. This modern city has problems similar to ones Chicago or Cleveland might have. For example, try and find a parking place.

Chile is made up of 25 provinces which are similar to our states in nature, each having its own capital. The Republic itself is divided into three zones; northern, central and southern. The northern zone is desert and is where the large borax, salt and nitrate mining operations are carried out on the high desert plateau. Gold, silver and copper are mined in the mountains with the latter being the largest operation.

There are three large mining operations. One is in the central zone, southeast of Santiago run by the Kennecott Copper Corporation, and known as Braden. Anaconda Copper Company has a large operation in the northern zone at Chuquicamata and another at Potrerillos. These camps are equipped with the best of North American machinery and equipment. Large steam power plants located at the ocean supply the large amounts of electric power required for the operation of the mines and smelters. The copper companies operate their own railroads and maintain their own highways. Hospitals,

(*Continued on page 104*)

Fig. 1. Antofagasta, Chile airport on way down

Fig. 2. Typical transformer bank at the smelters

Fig. 3. A strip of highway built by the Incas

Fig. 4. Chilean Yellow Cab and fire sale sign

Fig. 5. This was our home at the smelter town

Fig. 6. View of smelter and town at Papoti, Chile

Fig. 7. Andes Copper power station at Barquitta

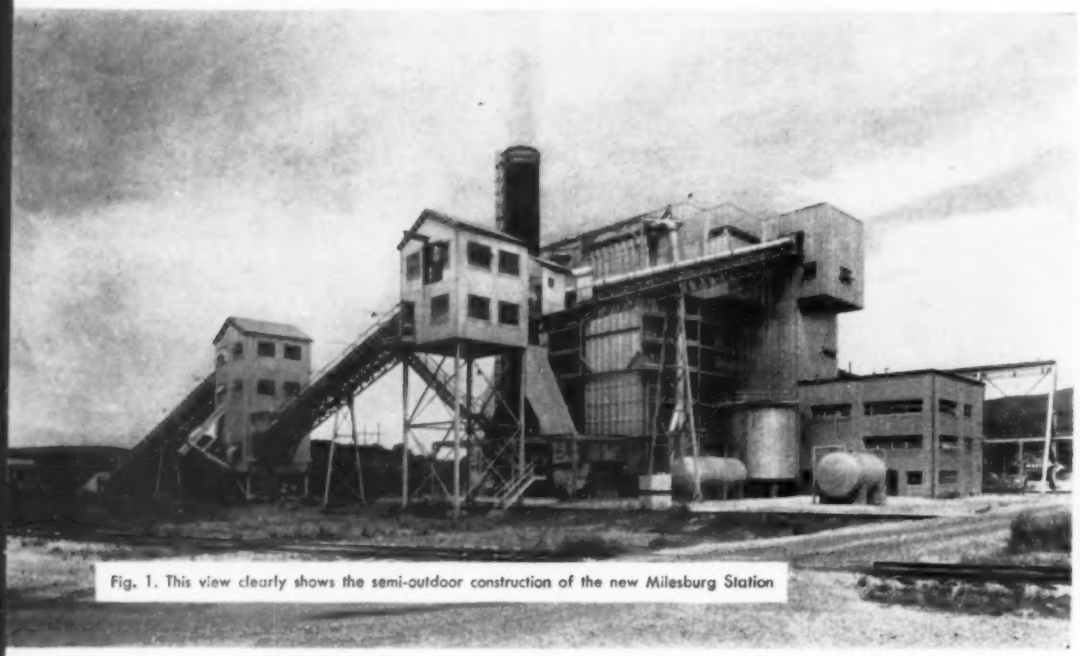


Fig. 1. This view clearly shows the semi-outdoor construction of the new Milesburg Station

MILESBURG

• • • Three Features

West Penn Power Co., faced with increasing costs, kept investment down by using semi-outdoor design, closed condensate cycles and minimum forced draft fan installation in their new station

By W. V. DRAKE, Manager of Power Production, West Penn Power Co.
R. A. MYCOFF, Superintendent, Milesburg Station, West Penn Power Co.

WEST PENN POWER Company, like other electric power companies, has endeavored to keep power rates low even in the face of increasing costs. Construction of the new 44,000-kw Milesburg Power Station, shown in Fig. 1, at an approximate cost of $160 per net kw including land, water rights and step-up transformers with breakers is one more story illustrating this principle.

Milesburg Station, in the Borough of Milesburg in Pennsylvania's Centre County, is located near the junction of Spring and Bald Eagle Creeks. The station contains initially two 22,000-kw turbine generators, served with steam by two 210,000 lb per hr boilers.

The plant was built as a semi-outdoor station in a northern area where outside temperatures drop to zero and occasionally lower. Full use was also made of the site's good limestone formation, which made it possible to practically eliminate excavations.

In order to simplify operation procedures and minimize equipment, with resultant saving in capital costs, a closed condensate cycle was employed. Figure 2 shows this cycle. Hotwell level is controlled by valves C24 and C27. If level in the hotwell decreases, C27 opens admitting water from the distilled water tank into the condenser. If level in the hotwell rises, C24 opens sending water to the distilled water tank.

Condensate Cycle

It was realized that as C24 opened, condensate pressure, which is normally 200 psig, would decrease and approach the head in the distilled water tank. Since the water leaving low-pressure heaters at full load is 290 F, a drop in pressure to the distilled water tank head would cause flashing. Therefore, an additional control feature was added to C24.

The impulse from high level in the hotwell controls C24 until condensate pressure drops to 150 psig. This second element then overrides the hotwell level impulse, keeping the valve at the opening that holds from 150 to 160 psig on the condensate system. The C24 valve is held partially open until hotwell level drops. The decreasing level bleeds the hotwell level impulse from C24 and the valve begins closing. Condensate pressure then begins to return to normal.

It was also realized that at full load, flashing would result in the boiler feed pump if the pressure at the inlet to this pump dropped to 82 psia. Consequently, to protect the boiler feed pumps (shown in Fig. 4), an ordinary pressure switch was added to energize circuits to simultaneously trip the in-service boiler feed pump, pulverizers, main generator breaker and main exciter breaker, and to transfer auxiliary power from a feed off the main generator to emergency power. This switch was set to operate at 100 psia, giving a small safety factor of 18 psi over the required 82 psia. This trip not only protects the boiler feed pump, but

gives the operating force of four men a safe and fast means of removing a unit from service.

Placement of the distilled water tank at approximately the same level as the condenser — ground level — presented difficulties in obtaining flow to the condenser during start-up periods. This was solved by the addition of a remote manual control element on DW5, which normally opens to feed undeaerated distilled water into the condensate pump suction line when level in the hotwell drops to an extremely low position. This addition made it possible for the operator to operate this valve from the control room and thus obtain required head between the distilled water tank and the feed point into the condensate pump suction line for required flow of water during start-up periods when the condenser is not under full vacuum.

In the original design DW6 was added as a manual bypass around DW5. During initial operations this valve was frequently operated and leakage of undeaerated water into the system resulted. Consequently, we had some difficulties with oxygen in our feedwater. This valve was then eliminated. Since this removal we have been able to maintain practically oxygen-free condensate at all loads. It has also been possible to maintain in excess of 5 ppm sulfite in the boiler by the addition of ¼ lb of sodium sulfite per day.

Forced Draft Fans

Placement of the forced draft fans outdoors presented not only the conventional sulfuric acid condensation problem but also an air heater tube plugging problem. Blasts of cold air onto the air heater tubes for extended periods condensed moisture from the exit gases which combined with fly ash to plug many tubes.

To correct these troubles a recirculating line was designed to permit bleeding of hot air from the outlet of the air heater into the suction to the forced draft fan. With this arrangement it has been possible to maintain a minimum inlet air temperature of 50 F. This holds the exit gas temperature high enough to prevent serious acid condensation. Air heater tube plugging has also been minimized to a point where routine cleaning during scheduled outages keeps this from becoming serious.

Figure 3 is a diagram of one of Milesburg's steam generating units. It is a two-drum boiler with high and low temperature air heater, pendant-type low and high temperature superheaters, and heat exchanger type desuperheater.

In line with holding investment costs down, each boiler was equipped with only one forced draft fan. Tests proved that this boiler could be operated at reduced load without a forced draft fan in service. Following these tests the sequential interlock system (induced draft fan trips the forced draft fan, which trips the

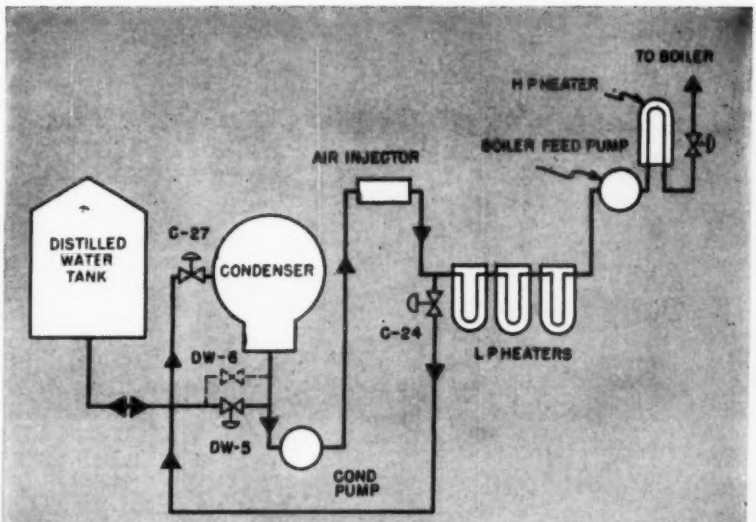


Fig. 2. Diagram of closed condensate cycle which was designed to simplify operating procedures and minimize equipment. Condensate has been practically oxygen-free

Fig. 3. Drawing of one of Milesburg's steam generating units showing high and low temperature air heater and superheaters, and heat exchanger type desuperheater

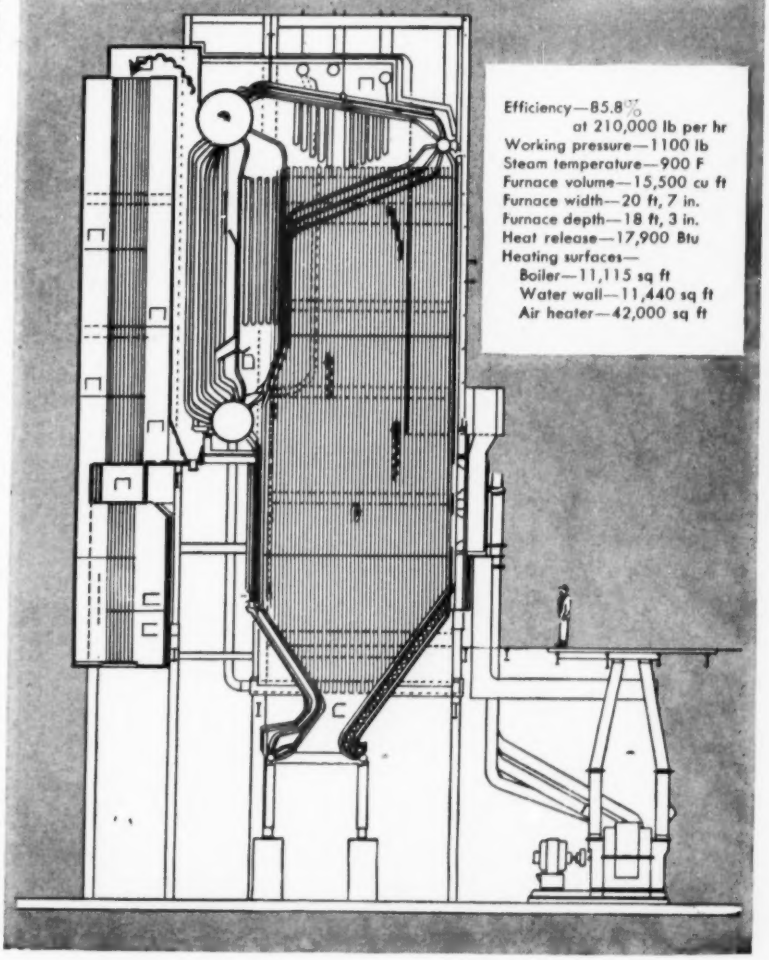


Fig. 4. The in-service and auxiliary boiler feed pumps at Milesburg Station

Fig. 5. Over-all view of one steam turbine and generator, rated at 22,000 kw

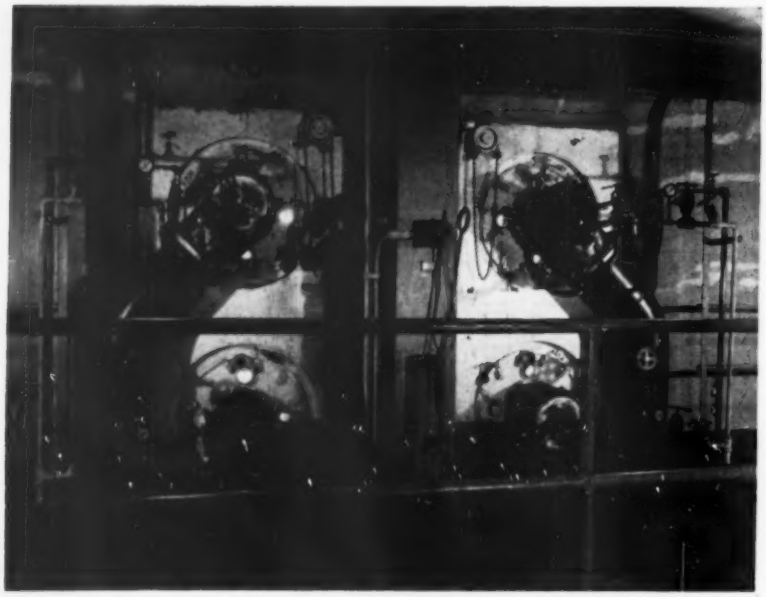


Fig. 6. This photograph shows the arrangement of bank of four burners in front wall of one boiler

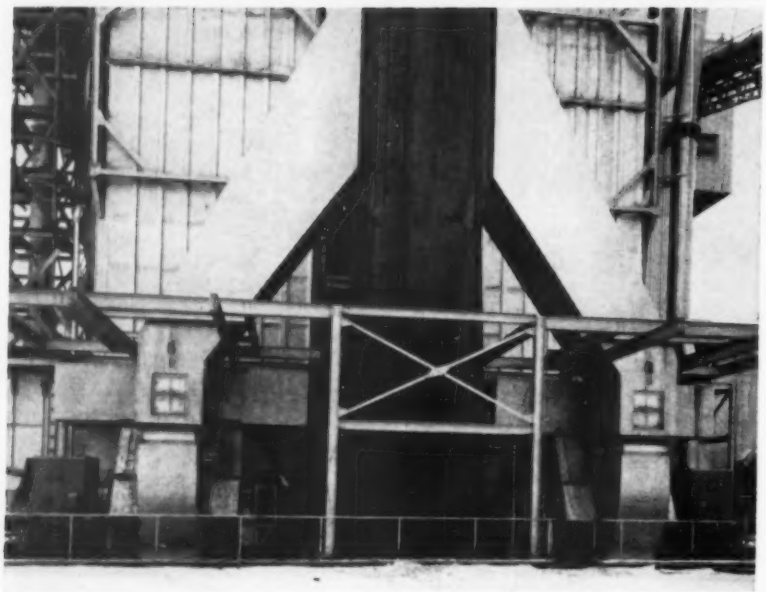


Fig. 7. In keeping with semi-outdoor design, induced draft fans were installed outdoors as shown

pulverizers, which in turn trip the coal feeders) was revised so as to have this protection for operation either with or without the forced draft fan being in service. This was accomplished by a wiring system which sent the tripping impulse from the induced draft fan to both the forced draft fan and pulverizers with the addition of a switch that selects desired tripping circuits.

Within a month following this revision to the interlock system, one of the No. 1 boiler forced draft motor bearings failed. During repairs the boiler was operated successfully at loads up to approximately 75 per cent of full load boiler rating. Actual maximum steam flow obtained was 160,000 lb per hr. Throughout this period steam temperature was held at the normal 900 F.

Soot Blowers

Difficulty was experienced in operating soot blowers at a boiler rating of 160,000 lb of steam per hr. At this load the induced draft fan could not remove exit gases and expanding steam from the soot blowers and still draw in enough air for combustion. Therefore, steam flow was dropped to 130,000 lb per hr while operating the blowers. At this load the soot blowing operation was successful.

In order to analyze conditions, 3½-hr comparative tests were run simultaneously with No. 1 boiler operating without the forced draft fan and the duplicate No. 2 boiler operating with forced draft fan. Coal to each boiler was identical within practical limits.

Results of this comparative test are shown in the table. Steam flow, percentage of carbon dioxide and carbon monoxide, excess air, drum pressures and superheater outlet pressures were identical. Draft conditions in No. 1 boiler were naturally lower than those in No. 2 boiler. Although

steam leaving the No. 1 boiler primary superheater was 47 F lower than the corresponding temperature in No. 2 boiler, the desired final steam temperature of approximately 900 F was still attained.

From heat balance computations No. 1 boiler had an 82.4 per cent efficiency compared to 87.7 per cent for No. 2 boiler. This showed a loss of 5.3 per cent while operating without forced draft fan. This difference is primarily due to higher carbon losses because of less efficient combustion and higher dry exit flue gas losses. The higher exit gas losses were due to a large percentage of the combustion air bypassing the air heater caused by the necessity of opening air heater doors; and also because of leakage of air through the boiler setting resulting from the high negative on the boiler.

Table shows results of the comparative tests in which No. 1 boiler operated without forced draft fan, No. 2 boiler operated with forced draft fan

	No. 1 Boiler	No. 2 Boiler	Variation
Steam Flow—lb/hr	155,000	155,000	0
CO_2—%	15.2	15.2	0
CO—%	0	0	0
Excess Air—%	22	22	0
Drum Pressure—psig	921	921	0
Sphtr Outlet—psig	880	880	0
Drafts—in. water			
No. 1 Mill Suction	−2.0	−0.4	1.6
No. 2 Mill Suction	−2.0	−0.4	1.6
FD Discharge	.....	+4.1	....
Secondary Air	−1.5	+1.4	2.9
Furnace Draft	−2.0	−0.15	1.85
Boiler Outlet	−2.5	−1.0	1.5
Air Heater Outlet	−7.0	−4.4	2.6
ID Fan Suction	−10.0	−6.8	3.2
Temperatures—deg F			
Feedwater	341	341	0
Steam, Primary Sphtr	755	802	−47
Steam, Desphtr	632	584	48
Steam, Secondary Sphtr	901	898	3
Outside Air	50	50	0
Air Leaving Air Heater	725	620	105
Gas Leaving Boiler	765	715	50
Gas Leaving Air Heater	480	319	161
Boiler Heat Balance			
Dry Flue Gas Loss—%	9.2	5.7	3.5
Unburned Carbon Loss—%	2.5	1.1	1.4
Hydrogen Loss—%	4.1	3.9	0.2
Moisture in Coal Loss—%	1.1	1.0	0.1
Moisture in Air Loss—%	0.2	0.1	0.1
Radiation Loss—%	0.5	0.5	0
Total Losses	17.6	12.3	5.3
Efficiency of Unit—%	82.4	87.7	

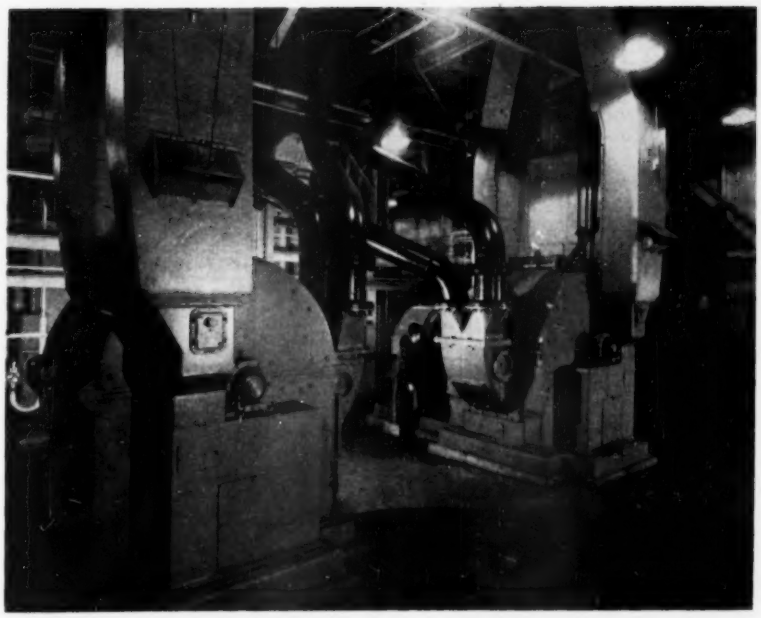
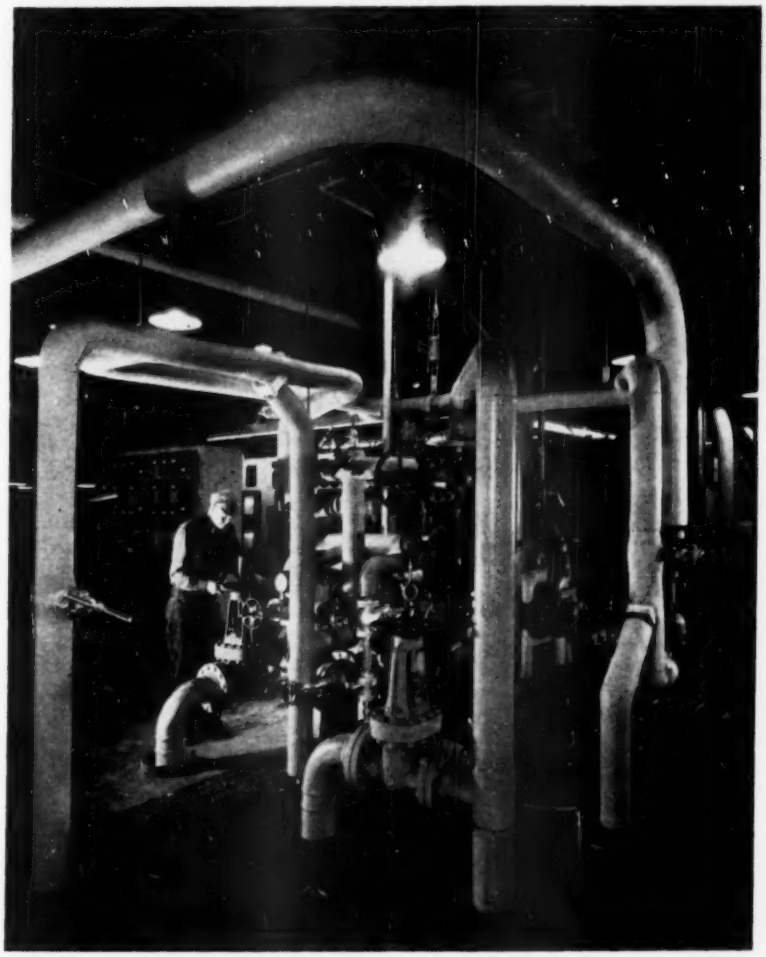


Fig. 8. These coal pulverizers condition the fuel for firing in the 210,000 lb per hr steam generators

Fig. 9. View in Milesburg Station showing the air ejectors serving one of the main turbine condensers



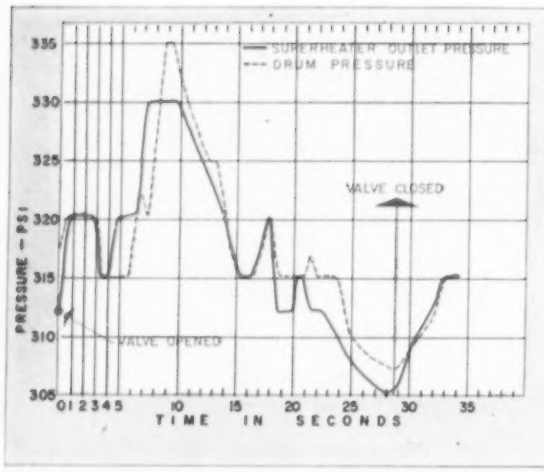


Fig. 1. Chart shows drum and superheater outlet pressure changes when power-operated relief valve was opened during firing up of cold boiler

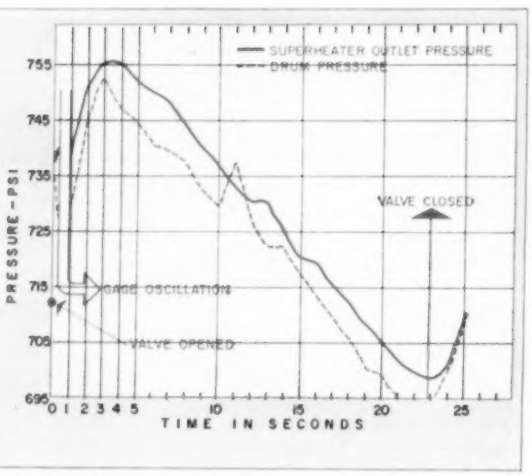


Fig. 2. Chart shows the effect of opening power-operated relief valve on drum and superheater outlet pressures when firing up a banked boiler

POWER RELIEF VALVE

Aids Superheater Venting in H-P, H-T Boiler Start-ups

By J. W. MACKENZIE

Electric Production Supervisor
Consumers Power Company

EVER PRESENT demand for reduced electric energy rates, even with greatly lowered value of the dollar, increased fuel costs, labor rates and higher taxes, has caused engineers responsible for power plant design to strive for greater efficiency and lower unit costs. It is quite natural that this search should call for higher steam pressures and temperatures.

Early studies showed that increased pressure, which was not difficult to design for, gave relatively slight improvement unless it was accompanied with a corresponding increase in superheat temperatures; and that pressure without sufficient temperature would result in excessive moisture in turbine exhaust, resulting in serious erosion of turbine blading and condenser tubes.

Boiler designers working for steam temperatures above 700 F found it necessary to place superheater elements where they were subject to higher gas temperatures. This required greater care in firing up a boiler to avoid overheating superheater metal before there was sufficient steam flow to cool the elements. It also brought a serious problem of finding materials to support elements in regular operation. Result was the so-called pendent design of superheater where elements are made up of a series of long loops hung vertically from headers above.

This type of superheater solves most of the supporting problems and adapts itself readily to furnace and boiler design, but it has the disadvantage that it cannot be drained and water condensed in the loops blocks free flow of steam from the inlet to the outlet headers. While it might appear that this water in the element would protect it from overheating, it has been possible, by installing thermocouples on various points, to show that water in the lower part of the loops may prevent flow of steam through the element. At the same time upper portions of the loops, with no steam flow through them and free of water, may reach temperatures of 1400 to 1600 F, or even higher, with resultant destruction of the metal.

Large Pressure Drop

A superheater designed for temperatures of 900 F or higher may have as many as 7 or 8 loops in series between the boiler drum and superheater outlet header, and with loops 18 to 20 ft in length it may require a pressure drop across the superheater of as much as 50 lb to force water out of the elements. This build-up in pressure drop will increase until it forces water out of a few elements. Usually this occurs in those elements subject to higher gas temperatures near the center of the boiler — higher temperature helping to clear the loops.

As soon as a few elements are free of water, steam from the drum flows freely through these elements tending to equalize pressure across the superheater. Once this happens there is nothing to clear water from other loops until either they evaporate dry or the boiler is under sufficient load to create resistance through the superheater to force water from the elements.

Boilers having a capacity of 400,000 lb per hr or more, designed for pressures of 800 psi or more, with final steam temperatures over 800 F, have generally been provided with about a 2-in. pipe vent to atmosphere to be kept open during the firing-up process. Instructions usually call for this valve to be kept open until a pressure of 40 or 50 psi shows on the boiler, after which it can be partly closed but kept open ". . . sufficient to assure some steam flow through the superheater." This type

of operation is, of course, rather inefficient as regards loss of pure water in vent steam as well as loss of heat. Greatest objection to the plan, however, is that it does not entirely prevent trouble. Tests have shown that a vent of such size will not clear the superheater elements of water.

In one case where, as a result of trouble on a 900 psi boiler of 400,000 lb per hr capacity designed for 900 F steam temperature, a large number of thermocouples were attached to superheater elements spaced across the boiler to show temperature of the metal near top and bottom of the elements. Somewhat of a surprise, it was found that some elements contained water which blocked steam flow even after the boiler was up to header pressure more than 4 hr after starting to fire. In fact, after the unit was under load the last of the elements were not cleared of water for more than ½ hr. Some portions of blocked elements reached temperatures of more than 1600 F.

Change in Procedure

Based on these results, the manufacturer recommended a lower rate of firing and longer period of heavier venting be used to bring the boiler into service, which was not only more expensive but rather unsatisfactory from an operating standpoint.

Tests had shown that with normal low rate of firing, for starting up a boiler, gas temperatures at the superheater will never be high enough to damage tubes with no cooling. To prevent overheating of the superheater it would therefore only be necessary to be certain that all elements were free of water before the boiler was placed under load.

As all high-pressure boilers of this company are provided with power-operated relief valves connected to the superheater outlet header, and considering the above mentioned facts, one of the operating men suggested a change in firing-up procedure. He proposed that all open vents be closed as soon as air was removed from the boiler system and, with header drain traps in service, normal firing continued until a pressure of about 350 lb was reached. Then, the power-operated relief valve was to be opened manually. This could be done readily by the remote control which is part of the valve design. The valve in this case is a 4-in. relief valve and at this pressure should have a discharge capacity of about 100,000 lb of steam per hr.

During first attempts at firing up a boiler by this method the power-operated relief valve was held open for 7 or 8 sec and produced quite unexpected results. It was thought that suddenly opening this valve would cause a decided reduction in pressure in the outlet header and so surge water out of the elements. It appeared, however, from pressure gages that there was an increase in header pressure despite the volume of discharge. A similar result was observed in bringing a banked boiler up to pressure. If the relief valve was opened at about 650 psi when bringing up a banked boiler connected to an 800 psi header the pressure increase would be sufficient to cause this boiler to discharge steam into the header.

With a view to obtaining more accurate data from which to establish best procedure for firing up boilers, one boiler was equipped with test gages to show pressure in the outlet header and boiler drum. An electric clock which had a long sweep second hand was mounted near them so a moving picture record of pressure changes could be made while operating the relief valve.

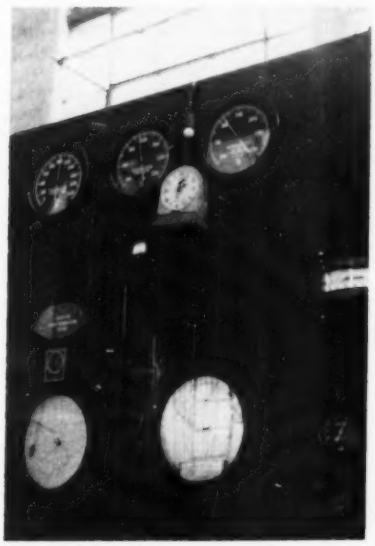


Fig. 3. Motion picture record was made of pressures and time on this gage board during the tests

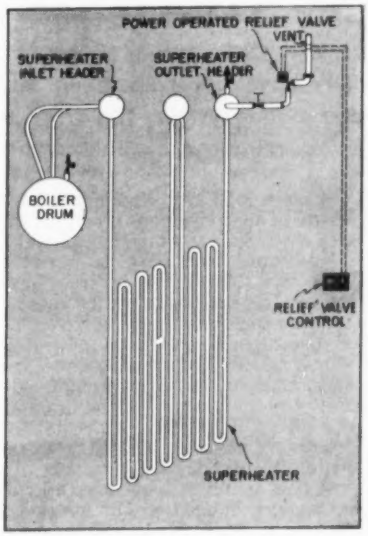


Fig. 4. Locations of power-operated relief valve and its remote control are shown in this diagram

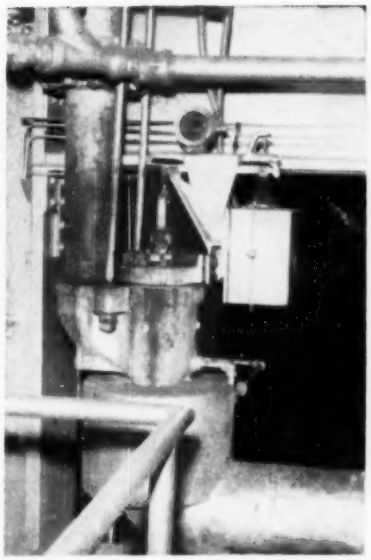


Fig. 5. Close-up of power-operated relief valve. Its operation will lower safety valve operation

Analyzing Results

Analysis of the photographic records obtained shows that during the early firing period upper portions of the superheater, which are not filled with water, become heated to a temperature high enough so that when water is surged from the lower part of the loops into these hot sections it flashes into steam, causing a sudden rise in pressure well above pressure corresponding to temperature of water in the boiler. This sudden generation of steam in the element forces steam and water back into the drum and the outlet header at the same time, raising pressure at both points. Keeping the power-operated valve open for a longer period will allow this increased volume of steam to escape, bringing pressure back to normal.

Figure 1 is a graph derived from moving pictures taken while firing up a cold boiler. It shows pressures plotted on a time basis when the power-operated relief valve is opened. It will be noted that pressure suddenly rises in the outlet header and at times exceeds pressure in the boiler drum; then with release of steam the header pressure drops below drum pressure. These changing pressures surge water in the elements first in one direction and then in the other, as is clearly shown by the graph.

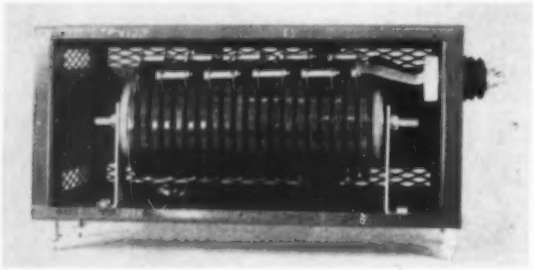
Firing Up Cold Boiler

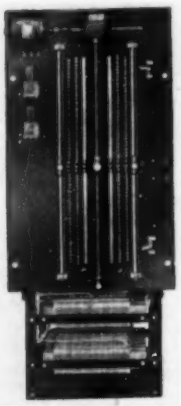
From data obtained by a series of tests at different pressures, and varying length of operation of the relief valve, the following schedule has been worked out as the best method for firing up cold boilers and for bringing banked boilers into service.

Fill the boiler to the bottom of

(*Continued on page 108*)

System Auxiliaries— —Resistors— —Rheostats—





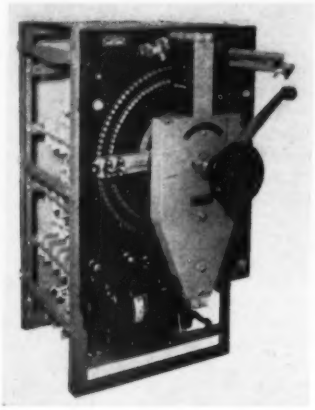


Fig. 1. (above) Thyrite discharge unit. Field circuit connections at right

Fig. 2. (middle) Front view of motor-operated Wheatstone bridge rheostat

Fig. 3. (right) Motor operated series type rheostat with dial type switch

Excitation Systems—1953 Style

Simplicity and reliability have generally been realized through use of standard, well proved excitation systems. This article deals with field switching, field rheostats, meters and relays, excitation cubicles and system layout

THROUGHOUT THE YEARS there have been many changes in excitation system design. Some of these changes have come about through new thoughts on the interconnection of related components. Others are due to advancement and improvements in the design of the components themselves. Many modifications in the over-all design have been tried. Many of these have not proved successful and have been discarded. Others have led to the development of the present designs.

Although some of the developments in this article are of fairly recent origin, a considerable amount of operating experience has already been gained from numerous installations. As a result of fine performance, this equipment can be expected to provide a long life of satisfactory operation from its use.

Because of the importance of the excitation system to the continuity of operation of the synchronous machine, the most important factors in its design are those of simplicity and reliability. Greatest simplicity and greatest reliability have generally been realized through the employment of standard and well-proved excitation systems.

Field Switching

In the design of excitation systems, it is a common practice to make use of a main field switch. When a fault occurs in a synchronous machine, the arc, with resultant burning, is maintained until excitation is removed from the field. This is true even though the machine may be disconnected from the line by the clearing of the line breaker. Optimum protection is afforded to the machine if the main field switch is opened immediately upon operation of the differential relays. The field is then quickly discharged through a resistor as the switch is opened.

A field switch is sometimes applied in the exciter field circuit instead of the main field circuit. This shows some advantage for hydrogen cooled synchronous condensers particularly, in that the heavy copper connectors from the exciter to the main field winding can be run direct, without bringing these leads first to field switch mounted apart from the synchronous machine. The disadvantage of this arrangement is that, with the opening of the excitation circuit in the exciter field, the main machine field current must discharge through the relatively low resistance armature circuit of the exciter. The result is to increase the time constant of field current decay and to maintain excitation on the machine for a longer period of time.

These switches are of the two pole type and are furnished either manually or electrically operated. Provided with the switch is a field discharge contact, which is open when the switch is closed. Upon tripping, this contact closes before the main contacts part, thus connecting the discharge resistor across the field before the circuit is opened.

The discharge resistor, which can be mounted with the field switch when the latter is supplied in an enclosed equipment, prevents a damaging voltage build-up in the main field winding when the field switch is opened. The value of this resistor is so chosen that a reasonably rapid decay of the field current will be provided without excessive voltage build-up across the field winding.

For back-up transient overvoltage protection on exciter busses, thyrite discharge units can be permanently connected. These are metal enclosed units and can be provided for either 250 or 375 volts. For high field currents, two or more are connected in parallel. The purpose of the thyrite units is to prevent excessive voltages upon a failure in the linear discharge resistor circuit, or, in the case of excitation busses, the inadvertent opening of a switch not protected by a discharge contact and resistor. The thyrite alone will hold the field voltage to about 800 volts when the field switch opens under normal generator operating conditions and to about 1500 volts when the field switch opens under most generator short-circuit conditions. In the latter case, the field discharge current may be in the order of five to six times full load field current. Since the linear discharge resistor (operating through a contact on the field switch) acts in parallel with the thyrite, the resulting voltages across the field will be less than those indicated. For field switch opening at normal generator oper-

This is the third article on this subject by Mr. Folger. The first one, in the September 1952 issue, discussed how parts go together to make up direct-connected or separate motor-driven excitation systems and electronic systems; the second article, in the December 1952 issue explained the use of voltage regulators.

Fig. 4. Cubicle. Field switch and discharge resistor — left; voltage regulator — center; exciter field rheostat and amplidyne motor-generator set — right

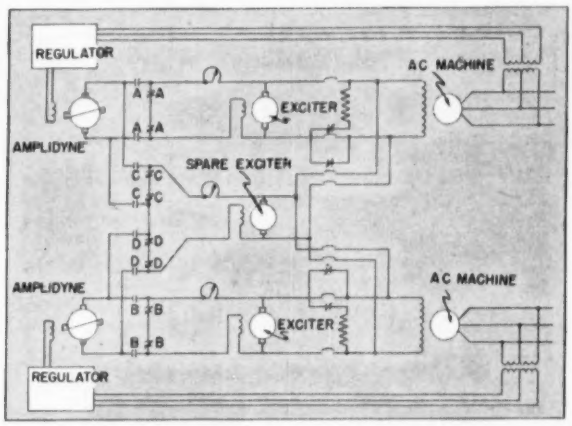


Fig. 5. Excitation system for two synchronous machines — one spare exciter and two amplidyne voltage regulators. Switching provided for spare exciter

By S. R. FOLGER, Central Station Engineering Divisions, General Electric Company

ating conditions, the resultant overvoltage will be much less for the parallel combination than with thyrite alone. A view of a thyrite discharge unit is shown in Fig. 1.

Field Rheostats

For applications involving a pilot exciter, a commonly applied rheostat is the Wheatstone bridge type, shown in Fig. 2. This is a 200-division motor-operated rheostat for mounting electrically between the pilot and the field of the main exciter. It is of the vertical screw type and controls the main exciter voltage from approximately zero to 110 per cent of rated voltage in steps of not over three-quarters of one per cent. A rapid field adjusting section is provided for use with the voltage regulator. This rheostat is of rugged design so that it can withstand continual readjustments which may be required by the voltage regulator. It can be supplied in a louvered enclosing case so as to present a pleasing appearance and to keep the current carrying parts free from accidental contact with any object.

A plate type rheostat is applied to control the pilot exciter field. This rheostat has sufficient range so that it can be set and left permanently to hold any normal pilot exciter operating voltage. The rheostat is arranged for back-of-board mounting.

For large self-excited exciters, a 164 division radial dial type motor operated rheostat is applied. This rheostat is designed to control the exciter voltage from 25 to 100 per cent of rated voltage in approximately one per cent steps. Sufficient resistance is always provided so as to be able to reduce the exciter voltage to residual. A view of this rheostat is shown in Fig. 3.

A single pole double throw position switch is mounted on the dial type switch. This position switch controls an indicating light which shows whether the setting of the rheostat is above or below a selected point. During voltage regulator control, the regulator compensates for the position of the rheostat so that some means must be available for the operator to determine the rheostat setting. This setting is important in that, when a transfer to manual excitation control is made, the setting determines the initial value of excitation following the transfer.

This rheostat can also be factory mounted in an enclosing case when desired.

For small turbine generator sets rated 9375 kva and below, a vernier plate type back-of-board rheostat is normally supplied. This rheostat consists of two plates operated by concentric handwheels; one handwheel controls the main plate and one the vernier plate. It is designed to satisfactorily control the exciter voltage from the minimum stable voltage to rated voltage.

Meters and Relays

Metering arrangements in an excitation system are extremely simple. From an operating point of view the only quantities of importance are the main field voltage and current and the field temperature. For these readings, a d-c voltmeter and a d-c ammeter are mounted at the main control switchboard. The shunt for the ammeter is commonly located with the main field switch when the latter is supplied in an equipment.

Field temperature recorders are normally resistance measuring devices. The resistance is measured by a bridge circuit which receives a current input from a shunt in the field circuit and a voltage input from either the main brushes or auxiliary brushes mounted on the collector rings of the synchronous machine.

Due to the vital importance of the excitation system in the continuous operation of the synchronous machine, tripping relays are not generally employed. Relays present in the excitation system are connected to alarm circuits so that trouble can be corrected by the operator, or, if

Table 1. Excitation systems quite commonly consist of the following equipment and auxiliaries

For large steam turbine generators:
- Direct-connected or motor-driven self-excited exciter
- Static type voltage regulator with amplidyne generator
- Series connected exciter field rheostat
- Main field switch with discharge resistor

For small steam turbine and engine-driven generators (Below 25,000 kva):
- Direct-connected self-excited exciter
- Direct acting rheostatic type voltage regulator
- Series connected exciter field rheostat
- Main field switch with discharge resistor

For hydroelectric generators:
- Direct-connected, separately-excited exciter
- Direct-connected, self-excited pilot exciter
- Indirect-acting rheostatic-type voltage regulator
- Wheatstone-bridge type exciter field rheostat
- Plate-type pilot exciter field rheostat
- Main field switch with discharge resistor

For synchronous condensers:
- Direct-connected self-excited exciter
- Static type voltage regulator with amplidyne generator
- Series connected exciter field rheostat
- Exciter field switch with discharge resistor (Hydrogen cooled machines only)
- Main field switch with discharge resistor (Air cooled machines only)

(Continued on page 111)

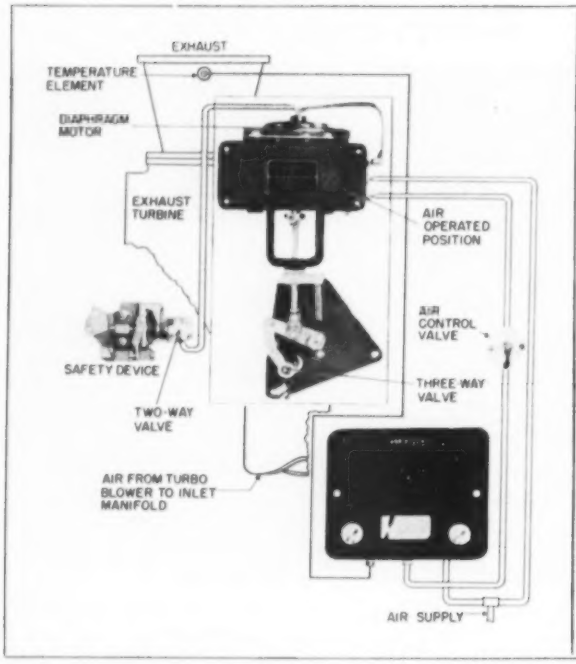


Fig. 1. This automatic thermal control was devised to use exhaust temperatures as a controlling medium. It can be easily preset to any desired temperature

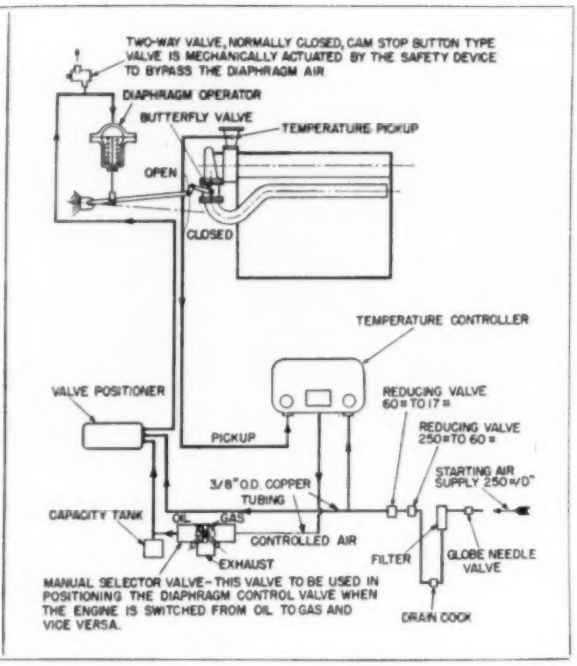

TWO-WAY VALVE, NORMALLY CLOSED, CAM STOP BUTTON TYPE VALVE IS MECHANICALLY ACTUATED BY THE SAFETY DEVICE TO BYPASS THE DIAPHRAGM AIR
DIAPHRAGM OPERATOR
BUTTERFLY VALVE
TEMPERATURE PICKUP
OPEN
CLOSED
TEMPERATURE CONTROLLER
VALVE POSITIONER
REDUCING VALVE 60# TO 17#
REDUCING VALVE 250# TO 60#
PICKUP
STARTING AIR SUPPLY 250#/D"
3/8" O.D. COPPER TUBING
CAPACITY TANK
OIL
GAS
CONTROLLED AIR
EXHAUST
FILTER
GLOBE NEEDLE VALVE
MANUAL SELECTOR VALVE - THIS VALVE TO BE USED IN POSITIONING THE DIAPHRAGM CONTROL VALVE WHEN THE ENGINE IS SWITCHED FROM OIL TO GAS AND VICE VERSA.
DRAIN COCK

Fig. 2. Application of the thermal control is illustrated in this diagram showing physical arrangement of valves and other equipment on a dual-fuel engine

OPERATING PROBLEMS . . .

By GEORGE STEVEN
Executive Engineer
Worthington Corporation
Buffalo, New York

Major problem of dual-fuel engines is poor fuel economy at partial load operation with constant air supply. Hand-operated, and now automatic, air throttling is one solution

. . . of the Dual Fuel Engine

OPERATION of a dual-fuel engine involves problems of control. Pilot injection, gas metering, and the use of injection valves were discussed in the August 1952 issue.

Another major problem was fuel consumption at partial load operation. With constant air supply, such as is used on diesel oil operation, it was noticed that, at partial load, fuel economy suffered very badly. It became clear that a gradual reduction in air quantity as load was reduced would be beneficial. Experiments were tried using a manual throttling device, and response in fuel consumption was immediate.

Next problem was how to produce this result in an automatic manner, which, of course, would be necessary for normal field operation.

There are two ways to do this: one, using governor control and throttling the air in proportion to the governor arm position. For satisfactory performance this required considerable development to produce an air control valve which would provide optimum throttling, since the governor motion is linear in character and air quantity requirement is not. Special shapes of valves, therefore, are necessary and can be produced to a reasonably satisfactory degree.

Effect of air throttling on exhaust temperature was very pronounced when operating with a hand damper. This indicated that the obvious solution would be to utilize exhaust temperature as a controlling medium.

Results are shown in Fig. 1, which illustrates the Worthington Automatic Thermal Control, consisting of a thermally responsive instrument and diaphragm-operated damper valve. Thermal element of the instrument is connected in the outlet of the turbocharger and can be preset for any predetermined maximum exhaust temperature desirable to maintain.

When load on an engine drops off, immediate tendency is for exhaust temperature to fall because of excess air for the load condition. The instrument comes into action and closes the damper valve in an effort to maintain present exhaust temperature and continues to function in that way regardless of load condition.

Obvious advantages of this arrangement are that no complications are involved in design of the damper valve, since regardless of shape, it will always seek the proper position for the degree of throttling required.

The device is properly equipped with safety features, so that when running at partial load and a sudden load increase develops the damper automatically trips to the wide-open position. This is done to eliminate detonation, which could result from the lag in exhaust temperature rise, a condition which would momentarily starve the engine of air at increased load rating.

When operating on 100 per cent diesel oil, the damper is automatically adjusted to the maximum open position. Diesel engines do not suffer at light loads from excessive air.

The dual-fuel engine is susceptible to detonation under maximum load conditions as the ambient tempera-

ture increases. It has been found by exhaustive testing that for any established maximum load condition at, say, 90 deg ambient temperature, that a reduction of 3½ to 5½ per cent of load, depending on cylinder bore size, is necessary for every 10 deg increase of ambient in order to eliminate tendency to detonate.

Detonation, without going into great technical detail, seems to be a function of mixture-temperature. Somewhere between 750 to 800 deg compression temperature is about the limit that can be reached without detonation developing.

Cylinder bore size, of course, has a bearing on this matter because the larger the bore is, the less efficient water jacket cooling becomes.

By use of suitable intercoolers, reducing temperature of the air after the turbocharger, load reduction can be recaptured; and if cooled low enough with available means, ratings can be increased beyond normal maximum for which the engine is generally sold.

Intercooling of dual-fuel engines is becoming more and more acceptable as a necessary factor where summer temperature conditions are higher than 90 F. Figure 3 shows in graphical form the effect of temperature on output. Obviously, if some means of further reducing temperature can be developed, greater outputs will be possible.

There are ways of accomplishing this by use of refrigeration, utilizing waste heat of the exhaust or cooling systems to operate an absorption type of refrigeration system which would provide sufficient Btu's to reduce air temperatures as low as would normally be desired — say, 40 to 50 F.

Increasing output of engines, however, involves many other factors. These factors will no doubt impose additional stresses on various engine parts so that it is not necessarily true that existing engines can be raised to these higher ratings. But new designs will no doubt be necessary.

Balancing of the engine should, of course, be carried out as close to the full load rating as possible. At or very near full load exhaust temperatures can be balanced between cylinders within plus or minus 20 to 30 F at the elbows. Firing pressures can be balanced comfortably within plus or minus 25 psi, and either of these figures is close enough for all practical purposes.

Somewhat noticeable is the tendency, under certain conditions, for slightly lower firing pressures on gas than on oil. In other words, if the engine is balanced as an oil engine for certain firing pressures and switched over to gas (assuming no detonation), firing pressures may be slightly lower.

There are two possibilities for this condition: one, the difference in combustion rate; and the other, the possible effect of ambient temperature on the gas operation. Gas engines generally seem more susceptible to ambient temperature condition than oil engines.

Gas Failure

One problem which has confronted everyone is the loss in frequency which results when a gas failure develops and the engine automatically switches over to oil as a fuel. This can be troublesome if the unit is a generator unit and operating in parallel with others, or in parallel with some other system.

When dual-fuel engines were first produced, nearly everyone incorporated a fully automatic governor mechanism which could utilize automatically any percentage of gas or oil. This necessitated cutting the full governor travel in two parts, one-half for gas and one-half for oil. Sensitivity of the governor was changed, since one half of the governor movement would produce a full effect on either the gas or the oil, depending upon which was in operation.

Smoother operation could be obtained by utilization of full governor travel, since twice as much governor movement would result in the same change of fuel injection.

There seems to be very little real need for this fully automatic feature and we are leaning toward utilization of full governor travel for either gas or oil.

A gas failure is the same as a gas pressure reduction below the point where the engine can be fed with sufficient gas to maintain its load characteristics. By arbitrarily deciding upon a minimum gas, a means has been devised when a gas failure is evidenced (by a reduction of gas pressure) for a mechanism which will, without delay, send the governor linkage to the oil position.

Figure 4 shows the mechanism for rapidly switching over to oil fuel when a gas failure develops. Gas supply pressure from the gas receiver is exposed to the pressure controller instrument. This instrument, in turn, applies pressure to the diaphragm of the 3-way valve, single diaphragm operated; maintaining this valve in an open position when the gas pressure is of adequate value.

When the 3-way diaphragm-operated valve is in the open position, air pressure is applied to the pressure controller instrument for its proper functioning and also to the pneumatic cylinder, which is engine-mounted.

When the gas supply pressure reaches a predetermined minimum value, indicating a gas failure, the pressure controller instrument functions to close the diaphragm operated valve, allowing air pressure from the pneumatic cylinder and the pressure controller instrument to vent to the atmosphere.

The pneumatic cylinder, which is spring-loaded, at once moves to a position which places the governor linkage mechanism immediately to the oil fuel position, permitting the unit to continue operation with a minimum loss in cycles.

The mechanism is again placed in operation, manually opening the 3-way diaphragm-operated valve when gas supply has been restored.

Fig. 3. Chart clearly shows that lower intake air temperatures raise the output of an engine a considerable amount

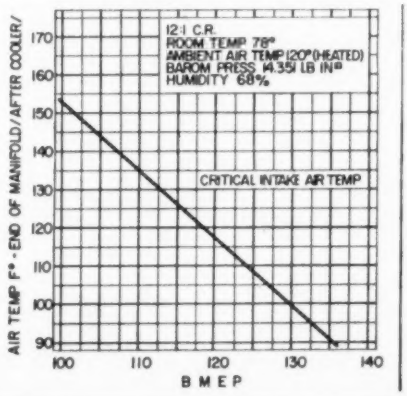
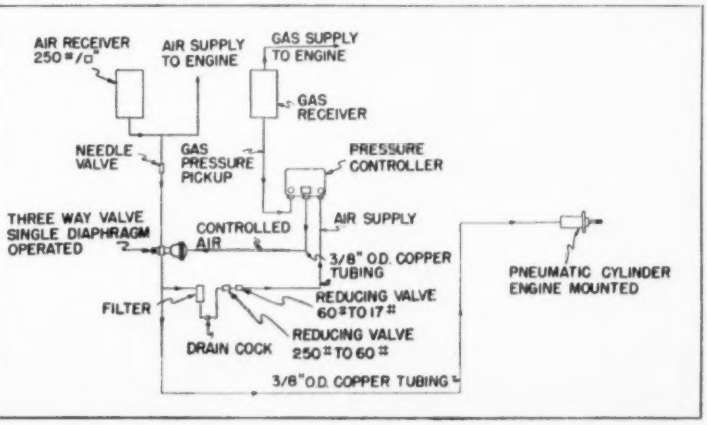


Fig. 4. Using gas pressure as controlling medium, this mechanism rapidly switches engine over to oil fuel when a gas failure develops. Reaching preset minimum gas pressure actuates the device



Where Industry Can Use the Gas Turbine

When ratio of industrial plant electric energy to heat energy is high, study combustion gas turbine carefully. This article tells you why, how and where you can use this new tool, the gas turbine, sometimes alone, sometimes with the steam turbine, to produce with high efficiency the industrial electric power and the process heat you need

By

W. C. BLOOMQUIST and W. B. WILSON

Industrial Engineering Department
General Electric Company

IN VARIOUS applications, the combustion gas turbine can be used to provide industry requirements for both electric power and heat energy.

Many industries find it economical to generate a part and, in some cases, all of their electric power requirements because of the large usage of steam as well as electric power.

Industries requiring large amounts of process steam have taken advantage of the economic savings in fuel by generating by-product power from process steam in automatic-extraction condensing, automatic-extraction noncondensing, and noncondensing steam turbines developed especially for this service. The power engineer now has an additional tool — the combustion gas turbine — which can likewise be used to supply the plant requirements for steam and electric power at high power-plant cycle efficiency.

Power–Steam Balance

In recent years, electric power requirements have increased much more rapidly than the steam in most industries. This is evidenced by the trend to higher initial steam conditions for noncondensing and automatic-extraction steam turbines.

The gas turbine can produce substantially more by-product power — two to four times as much as the process steam turbine — in most applications, as shown in Fig. 1. Combustion gas turbines with exhaust-heat recovery boilers can supply approximately 10,000 kw per 100,000 lb per hr steam flow and at an overall power-plant cycle efficiency of approximately 70 percent. This is comparable to the high-efficiency noncondensing steam-turbine-power-plant cycle.

Steam power-plant cycle efficiency is highest and the combined cost of steam and power is lowest when the entire electric power requirements can be generated as by-product power, using noncondensing or extraction-type steam turbines or gas turbines with exhaust-heat recovery to supply the steam required for process. The power-plant cycle efficiency decreases and the combined steam and power costs increase when it becomes necessary to generate condensing power. The extra kilowatts available from the gas-turbine cycle can minimize the condensing steam power required and improve the over-all power-plant efficiency.

How Gas Turbine Works

The combustion gas turbine is a very simple, self-contained prime mover and, based on experience to date, it is expected that the gas turbine will compare very favorably with other prime movers from the standpoint of maintenance. The simplicity, space requirements, and first costs are also points in its favor.

A simple open-cycle combustion gas turbine is shown diagrammatically in Fig. 2. It includes the compressor, combustion equipment for the burning of fuel, and the turbine. Atmospheric air is compressed in the compressor and then passes into the combustion chambers. There fuel is mixed with the air required for combustion and also with excess air required to maintain combustion gases within temperature limits.

These combustion gases are expanded through a turbine and are exhausted to atmosphere either direct or through various types of exhaust-heat recovery apparatus.

One interesting characteristic of the gas turbine is the effect of ambient temperature on its output; the lower the temperature the greater the output. For example, with an ambient temperature of approximately

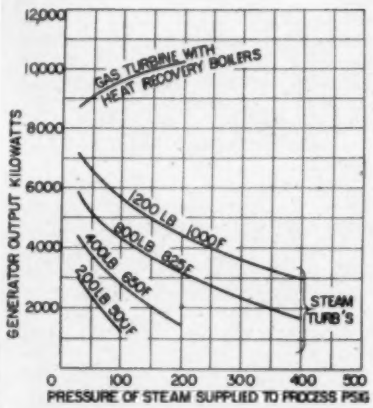


Fig. 1. Electric power which can be generated by simple-cycle gas and steam turbines when supplying 100,000 lb of steam per hour for process

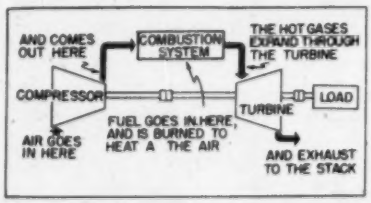

AND COMES OUT HERE
COMBUSTION SYSTEM
THE HOT GASES EXPAND THROUGH THE TURBINE
COMPRESSOR
TURBINE
LOAD
FUEL GOES IN HERE AND IS BURNED TO HEAT A THE AIR
AIR GOES IN HERE
AND EXHAUST TO THE STACK

Fig. 2. Diagram of a simple-cycle gas-turbine unit

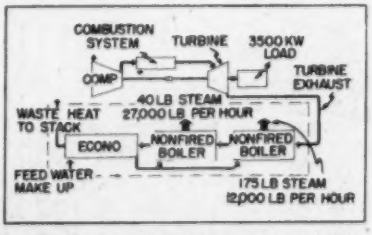


Fig. 3. Diagram of a simple-cycle gas turbine with exhaust-heat recovery boilers and economizer to recover heat from turbine exhaust gases

40 F, the output can be increased approximately 25 per cent over the 80 F rating.

Gas Turbine Applications

A few of the applications where combustion gas-turbine units can be applied to provide an industry's requirements for both steam or other forms of heat energy, and electric power are outlined below.

Exhaust-Heat Recovery Boilers To Supply Steam for Process: — Figure 1 shows the relation between the gas-turbine generator kilowatt output and the steam output from the exhaust-heat recovery boilers and immediately suggests an application for steam generation.

The arrangement for one plant requiring both process steam and electric power is shown in Fig. 3. Heat in the gas-turbine exhaust gases was to be recovered for the generation of steam in two boilers at two different pressures — 175 and 40 psig. From the last boiler, the exhaust gases pass through an economizer to heat feedwater for the boilers before exhausting to the stack. This arrangement would provide a total of 39,000 lb of steam per hour and 3500 kw of electric energy. This is a ratio of approximately 11 lb of process steam for each kilowatt-hour. Over-all gas-turbine plant cycle efficiency for this steam and power generation is approximately 70 per cent.

These requirements could also be supplied by a double-automatic-extraction-condensing steam-turbine plant. Over-all plant thermal efficiency of the steam turbine cycle would be approximately 52 per cent. This is lower than the gas-turbine plant efficiency for this particular application because the ratio of process steam to electric power is low and a high percentage of the electric energy must be produced by the condensing section of the steam turbine, which operates at a plant thermal efficiency of only 20 to 25 per cent. (If the process steam requirements were appreciably greater, then the efficiencies of the two cycles would be comparable.)

Use of the gas turbine with its higher power-plant cycle efficiency for this application would result in a fuel saving of over $60,000 per year based on a plant factor of 80 per cent and a fuel cost of 30 cents per million Btu. Initial cost of the gas-turbine plant should be lower and the cooling water requirements would be about one tenth that required by a condensing steam-turbine plant of the same kilowatt rating.

To Supply Steam for "Topping" a Steam Turbine Plant: — In plants requiring additional power generation, the gas turbine, with exhaust heat recovery boilers, can be used to top a steam-turbine plant. In plants where it is necessary to generate electric power but there are no requirements for process steam, a plant cycle arrangement such as shown in Fig. 4 will operate at an over-all power plant efficiency of approximately 28 or 30 per cent, which is appreciably higher than could be realized with a straight 400-psig steam-turbine plant of 15,000-kw rating. The arrangement shown is, in effect, a "binary" cycle power plant.

Such a "topping" arrangement might be particularly attractive in plants where additional electric power is required, where the existing steam turbines are in good condition but where the existing boiler plant must be replaced.

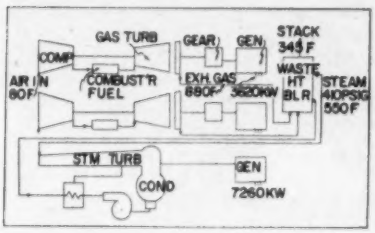


Fig. 4. Schematic diagram showing arrangement of gas turbines with exhaust-heat recovery boilers to "top" a steam turbine, at good over-all efficiency

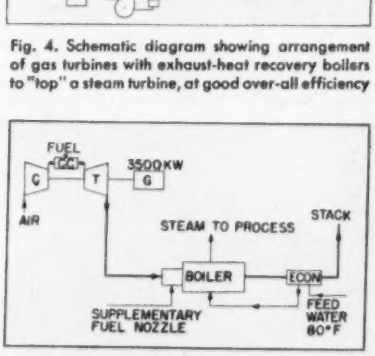


Fig. 5. Gas-turbine and exhaust-heat recovery boiler with supplementary fuel firing at low cost

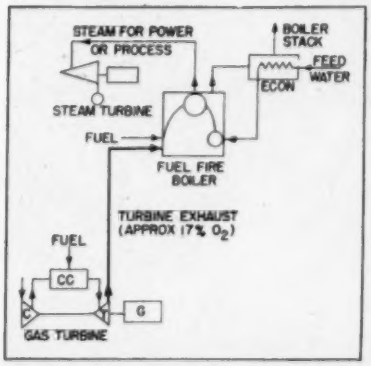


Fig. 6. A diagram showing a gas turbine supplying combustion air for fuel-fired steam boilers

Other Exhaust Heat Uses

In many plants there are uses, other than to generate steam, for heat which can be recovered from the turbine exhaust gases.

To Heat Feedwater for Steam Plant: — In a plant of the Oklahoma Gas and Electric Co., additional heating of feedwater for an existing steam plant was required. Gas-turbine power-plant cycle efficiency for the Oklahoma installation is approximately 65 per cent when credited with heat recovered from the exhaust gases. Heat recovery equipment is located just outside the turbine room with the gas-turbine exhaust gases passing through the feedwater heater and exhausting to atmosphere through a stack. Heat recovery from the exhaust gases of a 4000-kw unit of this type, in reasonably sized feedwater heaters or exhaust-heat recovery boilers, is approximately 40,000,000 Btu per hour.

To Dry Various Manufactured Products: — Still another application is the use of the gas-turbine exhaust gases for the direct drying of various manufactured products. Such products would include the kiln drying of lumber, drying various other types of building materials such as fiber boards, gypsum board and possibly various granular products such as insulation or even soap.

Because of the high efficiency of fuel combustion in the gas turbine, turbine exhaust gases can be used for the direct drying of many products without danger of contamination.

Although exhaust-gas temperature, as it leaves the turbine, may be too high for most of these applications, proper drying temperature can be automatically maintained by mixing atmospheric air with the turbine exhaust gases for temperature control as required. Humidity of the drying air can also be easily controlled by spraying water into the hot exhaust gases when required.

Depending upon physical arrangement of equipment within the plant, the gases leaving the exhaust-heat recovery boilers could also be used for drying.

Supplementary Fuel Firing: — When required, steam flow from the exhaust-heat recovery boilers can be increased by supplementary fuel firing.

Therefore, the gas turbine can be applied where the ratio of kilowatts to process steam, Fig. 1, is higher than the upper limit of the noncondensing steam plant but lower than the gas turbine operating with exhaust-heat recovery boilers alone. (Steam turbine 20 to 40 and gas turbine 10 to 12 lb process steam per kwh.) This is the area where by-product power generation would have to be supplemented by condensing power in a straight steam-turbine plant.

In this case of supplementary firing, heat recovered from the gas-turbine exhaust gases is supplemented by heat from additional fuel burned in the turbine exhaust gases between the turbine and the exhaust-heat recovery boiler. Additional cost of providing for this supplementary firing is low. All that is necessary is the addition of a section of refractory-lined ductwork and installation of the necessary fuel nozzles just ahead of the exhaust-heat recovery boilers, as in Fig. 5. This shows the exhaust-heat recovery boiler with the fuel nozzles for supplementary firing lo-

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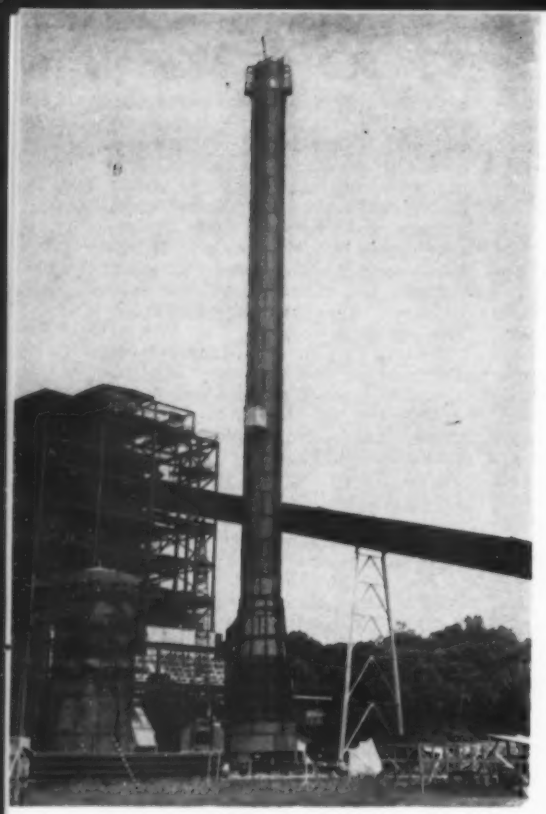
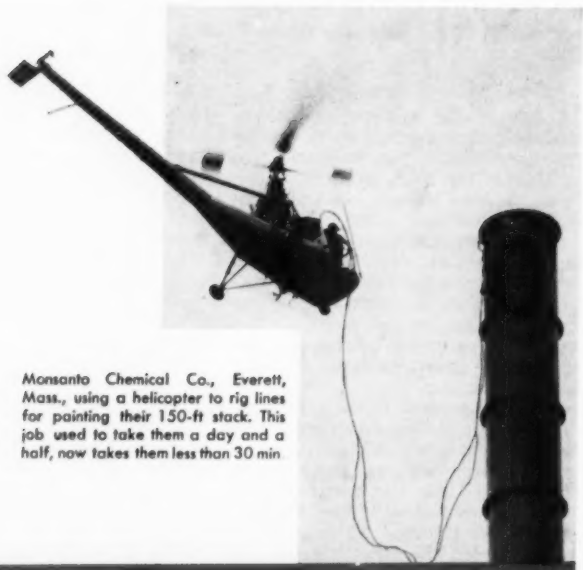


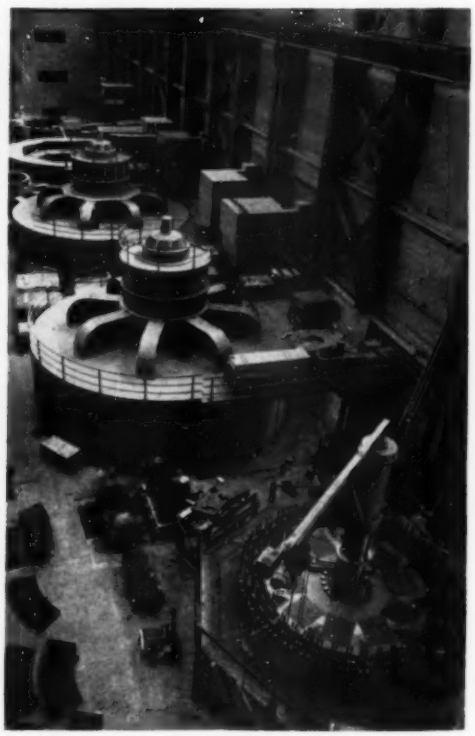
Tallest steel stack in the St. Louis area at Meramec Power Station of Union Electric Co. Erected by the Nooter Corp., it stands 250 ft high, is of all welded construction and is designed to be completely self-supporting—no guy wires



Monsanto Chemical Co., Everett, Mass., using a helicopter to rig lines for painting their 150-ft stack. This job used to take them a day and a half, now takes them less than 30 min

Power Engineering NEWS REEL

Left—One of eight Westinghouse Sturtevant wind-makers for the 4225 ft Squirrel Hill vehicular tunnel in Pittsburgh, Pa., on test



Right—Two Hungry Horse generators now on the line supplying more than 60,000,000 kwh of electric energy

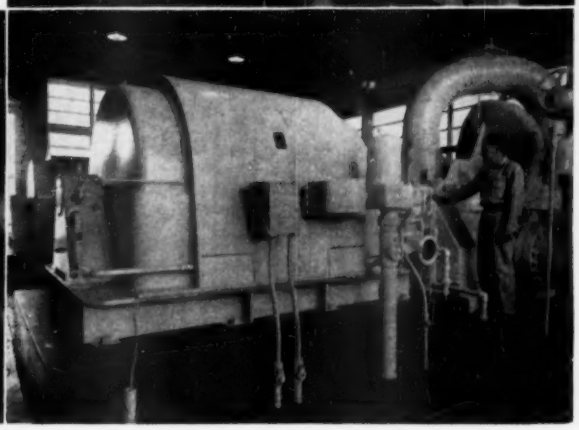
Above—New Hampshire Electric Company's new G-E mobile substation unit. It has a rated capacity of 2,000 kva and is designed to meet the varying voltage requirements of the company's 34 towns in N. H. and Me.

Above right—Power for the Owl's Head sewage treatment plant is produced by six Superior 1300-hp, turbocharged, dual fuel diesels and Westinghouse 1125-kva generators, using 90% by-product digester gas

Right—Springfield State Hospital, Sykesville, Md., has installed in its power plant a General Electric 700-kw turbine-generator set. This unit replaced a reciprocating steam engine and smaller turbine-generator set

Right—Parker Appliance Co. Triple-lox tube fittings in light metal for instrumentation and process piping in refineries, power and chemical plants, refrigeration and air conditioning equipment, and fuel systems

Below right—World's largest motors for oil pipe line pumping are these 3000 hp, 1780 rpm, squirrel-cage induction motors at the Norman, Okla., Basin pipe line system station, built by Electric Machinery Mfg. Co.



Below—Great Falls, Montana, Anaconda Wire & Cable Co., machines which once produced copper wire and cable exclusively are also turning out stranded aluminum steel-reinforced conductor as shown in this photo

Dealkalization—Without Acid

Chloride anion exchanger is a new development for reducing boiler feedwater alkalinity without use of acid. Chloride is substituted for alkalinity

NEW DEVELOPMENT in the water conditioning field is the chloride anion exchanger. Basically, the process consists in substitution of chloride for alkalinity content of water. The unit is regenerated with sodium chloride and, in effect, the process results in removal of alkalinity without use of acid, according to the *Betz Indicator*.

In conditioning boiler feedwater, sodium zeolite softening is often used. It has many advantages, outstanding of which are simplicity of operation and low hardness of effluent. Disadvantage is that alkalinity is unchanged by zeolite. This can contribute to high boiler water alkalinity and possible carryover of solids with steam. In addition, decomposition of bicarbonate and carbonate alkalinity within the boiler will release carbon dioxide, exerting corrosive effect on steam and condensate return lines.

Frequently, lime-soda softening is chosen for externally softening boiler feedwater because of reduction in alkalinity secured. Where alkalinity reduction is required following zeolite softening, acid treatment has been employed. Another method has been use of a hydrogen zeolite unit, usually operated in parallel with sodium zeolite, as shown in Fig. 1. Hydrogen unit removes alkalinity by converting sodium bicarbonate to carbonic acid, which is eliminated by aeration. The process, like direct acid feeding, requires handling of acid for regeneration.

These methods of reducing alkalinity all involve acid handling and are regarded with disfavor in small plants, without adequate personnel. In larger plants, with proper safety precautions and personnel, handling of acid is not a deterrent to use of these processes.

High boiler water alkalinity often accompanying sodium zeolite softening, and tendency for carryover, is no longer the serious problem it was prior to development of modern antifoam agents. With highly effective anti-foams it is possible to produce steam of excellent purity even with alkalinities formerly considered excessive.

Return line corrosion caused by release of carbon dioxide in steam also can be controlled by chemical treatment. Neutralizing and filming amines are used, with the latter achieving most prominence because of relatively low cost and protection against both carbon dioxide and oxygen.

Chloride Dealkalization

Dealkalization by anion exchange makes use of highly basic anion exchange resins employed in demineralization. In the latter, raw water is first passed through a cation exchanger where cations are exchanged for hydrogen ions. Calcium, magnesium and sodium are removed and cation exchanger effluent contains sulfuric acid, hydrochloric acid, carbonic acid, etc., which are absorbed by the second unit — an anion exchanger. The cation unit is regenerated with acid, the anion unit with alkali. This process, removing both cations and anions, produces an effluent comparable to distilled water.

Dealkalization differs from demineralization in that cations and anions are not removed from solution, but exchanged for other ions of less undesirable nature. Two separate units are used, as shown in Fig. 2. The first is a conventional sodium zeolite softener, regenerated with sodium chloride, which exchanges calcium or magnesium ions for sodium ions. Alkalinity, of course, is unchanged by this reaction.

Second unit, with a highly basic resin anion exchange material, also is regenerated with sodium chloride. In passage through this unit sodium salts, such as sodium bicarbonate, are converted to an equivalent amount of sodium chloride. Dealkalization unit removes anions in the influent by exchanging them with an equivalent amount of chloride.

Of course, there is no advantage in exchanging sulfate or nitrate for chloride. Where sulfate and nitrate content of raw water is high, cost of dealkalization is increased by these exchanges.

However, bicarbonate is removed by passage of sodium zeolite softened water through the chloride anion exchanger and this is the chief objective — removal of alkalinity without use of acid.

Exchange Capacity

Exchange capacity of the dealkalization unit is affected by several variables. There is evidence that exchange capacity for total exchangeable anions (bicarbonate, sulfate and nitrate) decreases with increasing chloride content of raw water; and indications that total anion exchange capacity (including raw water chloride) is not affected by variation of total anions in chloride form. However, capacity of the resin bed for bicarbonate removal will decrease with increasing chloride concentrations of raw water.

(*Continued on page 117*)

Fig. 1. A typical arrangement for hydrogen and sodium zeolite softening units in parallel. The hydrogen unit must be regenerated with a dilute sulfuric acid

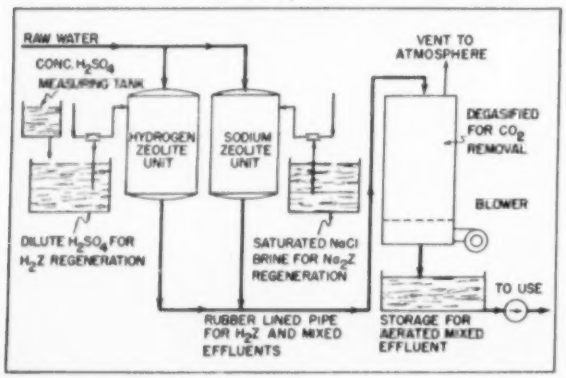
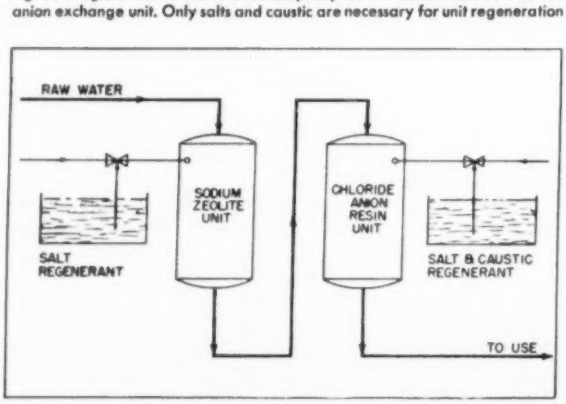


Fig. 2. Diagram shows the relative simplicity of the sodium zeolite-chloride anion exchange unit. Only salts and caustic are necessary for unit regeneration



Power Engineering's

PRACTICAL ENGINEER and ELECTRICIAN SECTION

CONTENTS

- **Water Treatment Engineering—Raw Water Treatment** 70
  by L. W. Fitzpatrick
- **How We Licked Sticking Coal** 73
  by Marvin E. Rule
- **Basic Power Plant Figuring** 77
  by William H. Engelman

practical hints and kinks 75

Percussion Lance Speeds Tube Cleaning

An Educated Ash Scoop
by Harvey C. Heckman

Cut Your Belt Ends Square
by F. E. Riley

Improved Conveyor Belt Scraper Works Better

questions and answers 79

How Much Steam to Heat Molasses?

What Changes are Needed to Drop Heating Steam from 125 psi to 15 psi?
Comments by — A. H. Moulton, H. B. Wayne, B. J. LaRocco, A. R. Eckert, C. E. Davis

Water Treatment Engineering
Raw Water Treatment

By L. W. FITZPATRICK
Chief Engineer
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CONSIDERABLE preliminary study in the selection of water and chemical process equipment will pay dividends in continuous satisfactory operation. Initially, the entire water treatment program should be carefully integrated into the master piping layout, pumping equipment and associated controls.

Many plants suffer from this lack of original planning and ultimately are put to needless expense by being forced to remodel and often discard inefficiently selected components. Efficient water and chemical handling equipment design cycles for the most part are simple, easy to install, control and maintain, and result in trouble-free operation during the entire plant's life.

The chemical composition of the raw water rather than the softening cost should always be the main consideration in the planning stage, since continual water concentration at elevated temperatures and pressure will give an entirely different color to the softening picture. Softener selection should be governed by the final softener effluent; the water behavior while in the boiler; and, all the time, the reduction of corrosion from the time water leaves the boiler header as steam, until it completes the heat cycle as returned condensate.

Every plant engineer over a period of time has developed his own pet ideas on the efficiency of the various water softening methods. However, a continuous study of the remarkable strides that are being made yearly, makes a reappraisal of all softener systems justifiable whether for new plant operations, or to continue the use of a softening system that has been installed for more than ten years.

Removal of suspended solids is the first step in every water treatment program. In many plants this is incidental, since the raw water supply is obtained from municipal or well sources which are clean and fully clarified. Filtration combined with chemical coagulants or sedimentation insures clear water. A sedimentation effect is often automatically obtained in the plant's operating and auxiliary water storage enabling the water to remain still, and be routinely switched from one unit to another.

This simple plan is most economical for low turbidity waters but a settling period over 24-hours is rated maximum, since a greater time is not warranted as solids removal will never be entirely complete and must be supplanted by an additional scavenging process to reduce remaining suspended solids.

Unless adequate soft water storage is available, size of water softening equipment required for boiler feedwater makeup should be calculated on the highest peak rate that may be expected rather than on average flow rate. Otherwise, the softening equipment will be overloaded during peaks and poor quality water will be introduced into the boiler system.

Regardless of plant boiler pressures, today's commonly established operating practice makes the removal of calcium and magnesium hardness absolutely necessary to minimize scale formation. Silica reduction is often placed on the same basis as hardness removal, although many plants successfully operate up to 450 psi with low silica content raw waters and small makeup.

External softening and water treatment can be classified into the following methods:

Sodium Exchange Ion Softeners

Based on elementary physical reactions, ions are electrical charges. Ions with positive charges of electricity are called cations. The negative ion is an anion.

The zeolite softener is the granddaddy of this group becoming first commercially successful in 1907. Since 1941, with the introduction of higher exchange capacity resins, zeolite softening has become recognized as the most efficient and economical method for producing soft water.

This is a simple base-exchange reaction where hardness forming calcium and magnesium salts are directly exchanged for non-hardness forming sodium salts.

Every zeolite is an imperfectly bound chemical compound protecting its original composition so that it changes chemically depending on the concentration of compounds in the raw water being softened. This inherent chemical construction is designed so that the sodium radical of the zeolite interchanges in any direction for calcium and magnesium.

Especially to be desired in a zeolite is high operating exchange capacity which reduces equipment size. Zeolites should also be suited for the raw water being treated and have an operating range of 6.5 to 8.2 pH and kept at an operating temperature below 150 F. New special zeolite resins have been developed capable of higher temperatures and pH range, but the higher cost must be carefully considered to justify their use under adverse conditions.

Zeolite grain structure should not be too fine which will cause a loss of head during operation and backwashing, nor, too coarse which will initially lower over-all exchange capacity.

It will generally be found that about five per cent of the zeolite will disintegrate and wash away annually. The entire zeolite bed should be thoroughly flushed every three months with chlorinated water to destroy

Advantages of Ion Exchange Systems

1. Freedom from sludge.
2. Low first cost and operating costs.
3. Freedom from dangers of excess chemicals in effluent.
4. No distribution system deposits.
5. Any hardness reduction is obtainable.
6. Virtually complete removal of silica.
7. Prepumping is un-necessary due to pressure softening.
8. Small space required, almost completely automatic operation, highly skilled labor is unnecessary.
9. Independent of change in raw water quality.

Advantages of Lime-Soda Process

1. Suitable for turbid and acid waters where zeolite cannot be used.
2. Effluent contains lower total solids than zeolite systems.
3. Corrosion prevention control is simple and easily installed to an existing filter plant.
4. May be more economical, and freedom from disintegration of material.
5. Has bactericidal effect.
6. Often required for excessively hard waters, particularly high magnesium hardness and high sodium content waters.

Protection of Brine Piping Used in Zeolite Softener Systems

Piping used in the brine system for the regeneration of zeolite softeners is often one of the major corrosion problems in the power plant. Corrosion, line plugging with rust particles can be easily eliminated by the addition of conventional refrigeration sodium brine treatment on the basis of one pound per 200–300 pounds of salt.

There is no interference with the regenerating action of the salt since these treatments are a combination of sodium salts and the treatment in fact actually aids regeneration by contributing additional sodium ion to the process. The nontoxic polyphosphate treatment forms a protective film on metal surfaces. When used with zeolite units treating water with high iron content, the treatment is particularly effective since it removes iron which tends to foul zeolite beds. This insures complete cleaning action and reduces required back pressure and assures maximum exchange capacity at all times.

bacterial growths. It is good practice never to leave a regenerated softener full of water for more than ten hours without use. When a softener is not re-cycled and used within a week's time, the zeolite should be left unregenerated and the unit completely drained. It will be found that zeolite exchange capacity will be improved by never back-washing with water harder than 10 grains (171 ppm). If the raw water is harder, it should be equalized below the above hardness figure by by-passing soft water from the auxiliary operating zeolite softener.

Although flow of raw water through a zeolite bed may be either upward or downward, use of the latter method is more common since less danger is present from carrying zeolite out with the effluent and improved bed filtering action is achieved.

A suitable formula for determining the size of zeolite softeners is as follows:

$$Z = \frac{K\,Q\,H}{G}$$

Z = cu ft zeolite to be used
K = exchange factor of zeolite used
Q = gal water to be treated before regeneration
H = average hardness of water grains-per-gallon
G = hardness to be removed between regeneration, per unit volume of zeolite, grains-per-cu-ft

With salt the most important single item in the cost of zeolite softening, effort should be made to keep salt consumption as low as possible. Experience has shown that about ½ lb of salt per 1,000 grains hardness removed, is the maximum that should be used with low capacity zeolites while 0.2 lb is possible with new high exchange types.

Loss of softening capacity of zeolite systems is often traced to the physical condition of the zeolite; flow rate through the softener bed; lack of sufficient salt regenerant; lack of uniform distribution of brine during regeneration. With all types of zeolites, it has never been found that running the softener to exhaustion before regeneration has had any bad effects.

Anthracite coal should be used in place of both sand and gravel in filter beds. The anthracite should be clean and free of long, thin and scaly pieces and have a hardness of 3.75 on the Moh scale with a specific gravity not less than 1.55. Unlike sand, anthracite coal will not add silica to alkaline water and because of the lower specific gravity of coal, lower and more economical back-wash rates may be employed.

Types of Treatment

Here are principal treatments. With the conventional zeolite exchange, sodium is the exchangeable cation and there is no reduction in dissolved solids since it replaces calcium and magnesium, and the resulting sodium bicarbonate alkalinity formed is undesirable in all boiler water. Substituting hydrogen for sodium as the exchange medium, we then produce a water with lowered alkalinity and greatly reduced total solids. With hydrogen softening a resinous exchange material is required due to the higher capacity necessary in removing heavy metal salts.

Regeneration with sulphuric or hydrochloric acid, changes the cations for hydrogen and calcium, magnesium and sodium all become acids. Carbonic acid produced being unstable forms carbon dioxide which is aerated and removed while mineral

Table I. (below) Water concentrations after various softening treatments

Average Water Concentrations After Various Softening Treatments

	Raw Water	Cold Lime Soda	Hot Lime Soda	Hot with Phosphate	(parts-per-million) Sodium Zeolite	Hydrogen Zeolite	2 Bed Demineralize
Total Hardness.	170	65	20	5	5	5	3
Alkalinity.....	115	95	45	45	120	2	5
Chlorides & Sulphates.....	55	65	55	55	65	70	6

Table III. (at right) Lime-soda, zeolite and hydrogen-zeolite treatment reactions

Table II. Rapid tests for softener operation and hardness test vs soap test

Rapid Tests and Calculations for Correct Softener Operation

All softener effluents should be regularly checked every 3–4 hours, depending on over-all efficiency of softener control system and water treatment operators skill.
Check Hardness (H) as ppm $CaCO_3$ Maximum range 25 ppm
Check Phenolphthalein (P) alkalinity as ppm $CaCO_3$
Check Methyl-Orange (M) alkalinity as ppm $CaCO_3$

Chemical Feed Control

2×P−M to equal 5–15 ppm (lime feed)
M−H to equal 25–50 ppm (soda ash feed)
When (2P–M) under 5, additional lime required.
When (2P–M) exceeds 15, decrease lime feed.
When (M–H) under 25, increase soda-ash feed.
When (M–H) exceeds 50, decrease soda-ash feed.

Example

H 20, P 10, M 25
2P−M=2×10–25=−5 additional lime required
M–H =25–20 = 5 additional soda ash required

Improved Hardness Test Over Conventional Soap Test

50 ml softener effluent
1 ml hardness buffer solution
2 drops hardness indicator solution
1 ml hardness reagent solution
Color change from red to blue = Hardness under 20 ppm

Lime-Soda Treatment Chemical Reactions

(1) $Ca(OH)_2$ + $Ca(HCO_3)_2$ = $2CaCO_3$ + $2H_2O$
Calcium Hydroxide + Calcium Bicarbonate = Calcium Carbonate Precipitated + Water

(2) $2Ca(OH)_2$ + $Mg(HCO_3)_2$ = $2CaCO_3$ + $Mg(OH)_2$ + $2H_2O$
Calcium Hydroxide + Magnesium Bicarbonate = Calcium Carbonate Precipitated + Magnesium Hydroxide Precipitated + Water

(3) $Ca(OH)_2$ + $MgSO_4$ = $Mg(OH)_2$ + $CaSO_4$
Calcium Hydroxide + Magnesium Sulphate = Magnesium Hydroxide Precipitated + Calcium Sulphate

(4) Na_2CO_3 + $CaSO_4$ = $CaCO_3$ + Na_2SO_4
Sodium Carbonate + Calcium Sulphate = Calcium Carbonate Precipitated + Sodium Sulphate

(5) Na_2CO_3 + $MgSO_4$ = $MgCO_3$ + Na_2SO_4
Sodium Carbonate + Magnesium Sulphate = Magnesium Carbonate Precipitated + Sodium Sulphate

(6) $Ca(OH)_2$ + $MgCO_3$ = $Mg(OH)_2$ + $CaCO_3$
Calcium Hydroxide + Magnesium Carbonate = Magnesium Hydroxide + Calcium Carbonate

Zeolite Softener Chemical Reactions

$CaSO_4$ + Na_2Z = Na_2SO_4 + CaZ
Calcium Sulphate + Sodium Zeolite = Sodium Sulphate + Calcium Zeolite

$CaCl_2$ + Na_2Z = $2NaCl$ + CaZ
Calcium Chloride + Sodium Zeolite = Sodium Chloride + Calcium Zeolite

When Regenerated

$2NaCl$ + CaZ = Na_2Z + $CaCl_2$
Sodium Chloride (Salt) + Calcium Zeolite = Sodium Zeolite + Calcium Chloride (Washed to waste.)

Hydrogen Zeolite Reactions

$CaSO_4$ + H_2Z = CaZ + H_2SO_4
Calcium Sulphate + Hydrogen Zeolite = Calcium Zeolite + Sulphuric Acid

Na_2CO_3 + H_2Z = Na_2Z + H_2CO_3
Sodium Carbonate + Hydrogen Zeolite = Sodium Zeolite + Carbonic Acid

(Carbonic acid is unstable and breaks up into H_2O and CO_2 (carbon dioxide) which is removed by aeration or degasifying.)

acids are then neutralized with an alkali.

An indicative test showing the gradual reduction of softening capacity of a hydrogen zeolite softener in service, may be obtained by the electrical conductivity method. When checked as placed in service after regeneration, micromhos reading will decline to about ⅛ initial reading as sodium ions break through reducing softening capacity. This is the result of the hydrogen zeolite reacting with sodium carbonate and forming sodium zeolite.

This is an anticipatory test since conventional hardness tests taken at the start of service will be practically identical when taken with the lowered micromhos reading.

Chloride dealkalization by anion exchange is a late development where the raw water is softened and chloride is substituted for raw water alkalinity content. A strongly basic resin is employed with sodium chloride the regenerant. Since these resins convert to chlorides and split salts exchanging their chlorides for bicarbonates, sulfates and nitrates, with high sulfate waters, the process is not efficient or economical. However, since most waters that are high in bicarbonates are usually low in sulfates, this process is attractive from the cost standpoint.

The dealkalization process offers advantages including the avoidance of acid storage, handling and special equipment; elimination of aeration and avoids repumping as units operate under regular system pressure.

Over-all efficiency of the dealkalization process can be seen from the following results:

	Hardness	*M Alkalinity*	*CO_2 in Steam*
	— parts per million —		
Original Raw Water	130	115	—
Hot Process Softened	20	15	14
Sodium Zeolite with Acid	2	15	11
Sodium Hydrogen Zeolite	2	15	11
Dealkalization	2	5	3

Demineralization — Sodium and hydrogen zeolites discussed are cation exchangers where one cation replaces another. By using a zeolite that exchanges anions in a combination of both types, dissolved salts can be completely removed providing an effluent which is practically the same as distilled water. Distillation can be purposely omitted since modern demineralization has supplanted this type softening in all new central station and large high pressure industrial plant installations.

Lime-soda Softening — Every power plant engineer has at one time or another come in contact with "lime-sody-ash" softeners. Whether cold-lime, cold-lime-soda, cold-lime zeolite, cold-lime barium, hot-lime-soda, hot-lime zeolite, many details vary as to operation and design, but the softening principles remain the same. With the addition of calcium hydroxide and sodium carbonate to the water to be treated, calcium hydroxide reacts with calcium and magnesium bicarbonates precipitating them as calcium carbonate and magnesium hydroxide. Other soluble calcium compounds are converted by sodium carbonate to calcium carbonate and the corresponding sodium salt.

Soluble magnesium salts are removed by the combined reaction with lime and sodium carbonate, with magnesium being converted to the insoluble hydroxide.

All softening reactions when taking place at low temperature proceed at a small pace with the resultant precipitates of fine particle size and slow to settle. Hot process softeners offer greater reaction speed with faster settling rates and offer additional economy in chemicals as the sludge is partly recirculated.

Supplementary chemical treatment is always desirable with lime-soda softening. Iron and aluminum compounds will aid in settling finely divided precipitates by forming gelatinous hydroxides. Sodium aluminate hydrolizes to form aluminum hydroxide, an efficient flocculating agent and sodium hydroxide. It will precipitate the magnesium as the aluminate, and coagulates a considerable part of silica as magnesium alumino-silicate while the sodium hydroxide acts with calcium hydroxide as an additional softening agent. Sodium carbonate formed reacts with non-carbonate salts.

Addition of magnesium salts reduce silica under controlled temperature and alkalinity. A part mechanical and chemical process, magnesium hydroxide is formed by the hydroxide alkalinity and the magnesium salt used and acts by adsorption. Ferric hydroxide formed by various iron salts also aids in silica removal.

Phosphoric acid or phosphate salts added after lime-soda remove residual calcium and magnesium salts. The phosphate reaction should be entirely complete and the final effluent filtered before being used as boiler feed to reduce feed line sludge deposits.

As water softener reactions follow chemical reaction velocity which is accelerated with temperature rise, sulfate reactions are completed in less than ten minutes at 205 F while with 70 F water, they are not completed after five hours. Hot process precipitates being larger settle out easily while cold process being finely divided, settle very slowly. It therefore follows that residual scale-forming

solids from hot process treated water are lower than a cold-process treated water.

Greater economy and more efficient results will be obtained with lime-soda softening by the use of excess lime; use of aluminum or ferrous compounds; sludge recirculation; and combining lime-soda process with zeolite softening.

Addition of 34 to 52 ppm excess lime followed by sufficient soda ash will react with non-carbonate hardness and the excess lime will completely precipitate magnesium. Excess lime can be determined by a phenolphthalein test where P alkalinity is equal to one-half M alkalinity, only normal carbonate alkalinity is present. If P alkalinity is greater than one-half M alkalinity, excess caustic alkalinity and lime is indicated.

Hot-lime zeolite process today is replacing other more costly treatment methods. This system produces an excellent effluent; has demonstrated relative lack of deterioration of styrene ion-exchange resins; has a low operating cost and the use of zeolite as a polish treatment produces a water of practically zero hardness.

With all external softening systems, operators should run hardness and control tests at frequent intervals, as water conditions can change rapidly dictating treatment adjustments.

To prevent boiler deposits, zeolite softeners and ion exchange are effective softeners. Under proper operating conditions for all practical purposes, zero soft water is produced, and leakage of hard water into the condensate is the only source of scale. Zeolite softeners with automatic controls are more simple to operate than lime and soda-ash softeners in small plants where skilled attendance is not available. In a large installation where several zeolite units would be required either with a combination of hydrogen exchangers to reduce softener effluent alkalinity, lime and soda-ash may be the suitable softening means.

Operating conditions as availability of exhaust steam and hot water from process cooling are often the factors for selecting a hot process treatment. The requirement for cold soft water for processes will dictate a system that will treat water for boiler feed and plant process supply. A systematic approach to all softening problems and combining the overall operations will invariably give initial lower first cost as well as convenience in operation.

Changing plant process requirements require a thorough study of all present and future water applications taking into account operating costs and capital investment. With the use of all types of ion exchange equipment, the additional cost of neutralization of back-wash waters must be considered since lime or soda ash is required to acid softener wastes. Salt brines can usually be diluted with other plant waste waters to comply with every widening local and state board of health requirements.

One development that offers considerable promise in the field of raw treatment of plant water is the newly perfected membrane system used with electric currents which separate salts from water by an "electrical ion exchange." While now designed for producing large quantities of fresh water from salt water, this method can conceivably eventually be perfected for complete ion exchange. The synthetic membranes composed of low cost coal, tar and chemical compounds, while not entirely identical, are very similar to the different purifying membranes of the human body including those associated with the kidneys, nerves, lungs, blood vessels and intestinal tract.

Sea water which contains about 3½ per cent salts when pumped through this equipment has a final effluent of about 67 per cent suitable process water and the remainder brine. It is possible with the brine to recover salts of potassium, bromine, and magnesium which are now easily recovered from less salty sea water. Electric power cost is calculated at around six cents per 1,000 gallons and complete cost including amortization of equipment would range between 10 and 20 cents per thousand gallons.

This membrane process differs from so-called electrical scale removers offered today, in that the membrane acts much as a filter electrostatically ionized which collects salts. Electrical scale removers purportedly do not collect scale salts but merely change the polarization of the ion, which has always been subject to debate as to their effectiveness.

How We Licked Sticking Coal

Here is a good example of the ingenuity many power station men have. Give them a problem and let them go and they will find a solution

By MARVIN E. RULE

Power Engineer, Princeton University

FOR THE PAST TEN YEARS, the problem of how to keep our coal from forming sticky arches in the stoker-hopper during the spring, late fall and winter has been uppermost in our minds. During these periods, long faces among the helpers and firemen was a common sight.

The first attempt at doing something about this problem was just a gadget which worked on the principle of a rocking bell-crank. The crank would rock forward and backward in time with the revolution of the stoker. The rams were on a crank and each ram would make its full turn 120 deg apart. As the rocker bell-cranks could not possibly make the arms, which pushed up and down into the coal do the work they were supposed to do, the thing failed. This failure did tell us one thing. It was possible to keep the coal moving in the ram that was synchronized nearest to the movement of the bell-crank motion. Much thought and time had been spent on the idea. Most of the work had been done by the originator of the idea, on spare time, because all hands were having a good time giving our experimenter the grand old Bronx cheer any time parts were seen about.

Another device was made with the idea of many tines churning in the hoppers of the stokers. Three, one-half inch rods were used in each ram hopper and set 120 degrees apart. They ran through a two in. pipe and there were actually six tines, 60 deg apart turning in the coal on each of three rams, making a total of 18 half inch rods eight in. long. Some moved easy and some were forcing themselves through solid standing coal, depending on the rams position. The two in. pipe was turned by a chain drive, fastened directly to the end of the stoker crank shaft. The power problem had us licked. The stoker engines ground and the chain jumped on its sprockets. One solution thought of was to reduce the number of tines, and make those that would be left turn down when the rams were withdrawing from the coal boxes. This did help, but these same tines that had gone down had to again turn up and they were then covered with at least a foot of coal. The coal was attempting to run down in the hoppers and the agitator tines were turning up. The stoker engines did not work quite so hard, but our chain drive could not stand the gaff. Slipping of the chain on the sprocket only a tooth at a time soon had the tines out of cycle with the rams and trouble again developed. This gadget did prove one other thing, that for short periods when it did run in step with the rams the firemen and their assistants did not have to poke the coal down. The proof of the pudding is in the eating and so it was with

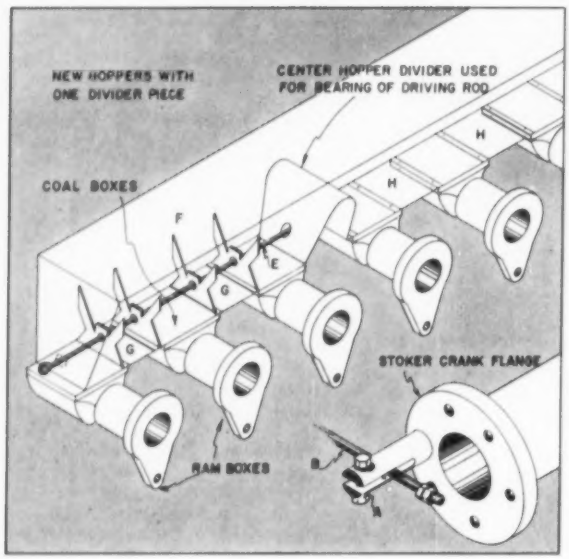


Fig. 1. (left) Cross-section of new hopper showing how agitators were installed

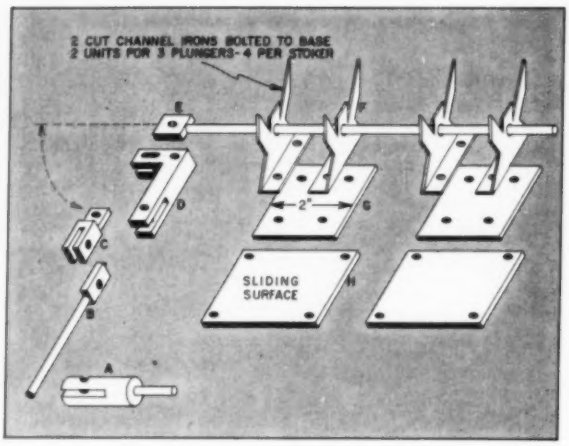


Fig. 2. (above) Exploded view of the materials used to make the coal agitators

the men, the impossible had been accomplished if it was for only a very short period of time.

With this amount of progress as a bench-mark, a new approach was attempted. The idea was not wholly original. The principle was reciprocating motion at the base of the coal box, but to do this, new hoppers would have to be fabricated. The original hopper design was small. It was a known fact that the coal arching took place six inches or so above the ram itself.

The original hoppers were finally replaced with one single hopper to feed the three rams. The coal box for each ram was a separate unit, and in between each unit there was nothing to hold the coal from running on the floor. To overcome this, pieces of steel ½ in. thick were bought. They were drilled to match the holes existing in the coal box pieces, and made a solid base across the ram boxes. This piece in Fig. 1 is labeled "H". The "H" piece was bolted in place with countersunk bolts to leave a smooth surface. The thing puzzling us now was what to use for agitators or reciprocating pieces. The idea of using a piece of eight in. channel was brought up, but channel was very thin and we wanted to keep movement down to a minimum to conserve power. A solid rectangle would surely not be needed, because we did not wish to move the coal, we only wanted the arch broken. Finally it was decided narrow portions moving near the hopper sides would knock down any sticky coal in the hopper eight inches or so up. After much deliberation it was decided it was necessary to break the arch next to the rams as well as on the hopper sides. Two channel pieces as "F" were cut and mounted on another ½ in. steel plate "G". The plate was made two in. shorter than "H" so that with two in. of reciprocating motion the plate "G" would travel to the coal box edge. This we felt sure would not allow any arching. First the channel top web was removed and the remainder cut to shape as shown "F". Two channel pieces were bolted to plate "G" to form each unit. Four complete assemblies were made consisting of two pieces of "F", on piece "G" and the stationary piece "H" which spanned across the ram boxes.

The stoker is a six retort type, therefore, the two units on each of three rams would take care of any arching. A ⅞ in. rod was chosen to drive the agitators, and the agitating units had to be fastened to this rod. Two collars with set screws were used to secure the units in their proper places and to give them their drive. A pipe spacer was used between the two channel pieces, so a hard push would not collapse our units. They should have a support or guide on the far side of the three rams to keep the riding plates from getting out of place and becoming caught. The guide problem was overcome by leaving one of the hopper separators in the middle and drilling a ⅞ in. hole at the proper height. This was to be the guide. The rod length was cut so we had better than four in. between them when each drive rod was at its extreme out position. This would allow each agitator to operate in synchronization or otherwise without difficulty from the two coming in contact with each other.

How To Drive It?

The coal moving part was done, but how to drive it? Reciprocating motion was the end motion. The drive would or should be rotary from the stoker crank. The stoker cranks had flanges on them, but the holes in them would give us a seven in. throw and to drill these flanges closer to center would mean drilling into the shaft proper as it is three in. in diameter. The seven in. throw had to do and we would have to reduce this to the needed two in. Taking this step meant a bell-crank reduction would be needed, and we also recognized that to reduce from seven to two in. would mean a lot of motion out beyond a safe distance from the stoker. We finally came up with three pieces of ½ in. steel riveted together as "D" for the bell-cranks. One end was slotted one in. long and the other drilled to take a ½ in. bolt. The long end was about six in. and the hole was drilled back an inch or so. The slotted end was but 2½ in. long, so we were short of the needed reduction. We overcame this by using lost motion on "B" and the driving unit "A".

More problems confronted us at this point. The rotary motion of seven in. not only gave us the needed reciprocating motion but we also got unneeded up and down motion which had to be eliminated. The answer was a universal joint of some sort. The original universal which we used was good because the joint was so built that the push was applied ahead of the connecting bolt and this eliminated any buckling effect. The bad part of this joint was that it was cumbersome if made heavy and too weak if made light. Incidentally this joint as made up is still working after two years, but it had to be cased in a three in. nipple to prevent trouble. The description of this joint is probably enough to let the reader know a more satisfactory and less conspicuous device could be made. The joints now in use on 3½ in. stokers are shown in the sketch as "C". These were made from a piece of two in. sq bar stock about six in. long. From this statement you will note the parts are not drawn to scale but are shown only for the purpose of description.

The part "B" is a drive bar and was made from $\frac{7}{8}$ in. cold rolled steel with a solid piece of flat stock welded to the end. This works in the universal joint and is threaded about eight in. on the lost motion end. Two nuts were split and one half locked against the other on each side of the driving knuckle or crank piece "A". "A" is a piece of steel turned to $1\frac{3}{4}$ O.D. and is drilled to take the $\frac{7}{8}$ in. rod "B". The opposite end was turned to $\frac{7}{8}$ in. and threaded. The threaded end was inserted into one of the holes in the flanges which are on the stoker cranks. Two nuts were used to tighten and lock this piece to the flange for a running fit. One stoker did not have flanges on the cranks, therefore, we were forced to make a crank. This was made from a block of steel three in. wide and $1\frac{1}{4}$ in. thick. It was machined to make it look neat and at the same time a strong slot was milled into the one side $1\frac{1}{2}$ in. wide and $\frac{1}{4}$ in. deep. This was to be placed against the stoker crank end. The stoker crank shaft end was drilled for two $\frac{5}{16}$ in. screws and a block was fastened on the end. The block was $\frac{1}{4}$ in. thick and the full width of the shaft (three in. long with ends rounded to match the shaft end). The width and depth match the milled cut made in the agitator crank-piece. The two pieces were placed in position and the whole unit drilled and tapped for a $\frac{3}{4}$ in. bolt. By using the $\frac{3}{4}$ in. bolt all the pieces were held very tightly to the stoker crank-shaft preventing severe shear strain. The agitators moved so freely we found that building a crank on this stoker did not present the expected problem of holding the crank piece together without shearing the bolts that held it in place.

The agitators worked so well that one of our firemen felt it was a shame to have them working, when it was not necessary and suggested that instead of having the units work continually, we remove the piece "A" and slot it, as it is shown. A hole was drilled down across the slot so that a $\frac{3}{8}$ in. bolt was dropped in to hold rod "B" from falling out. Now when the coal is running free the firemen lift the $\frac{3}{8}$ in. bolt out, disengage the push rod, and let it hang down alongside the stoker, out of the way. This improvement really made the gadget quite complete.

The material used was from stock, used in most any maintenance shop. The time used, was mainly spare time of men who were anxious to help themselves. Our force, especially the operators appreciate the effort of the different groups, who helped to make and assemble these agitators.

PRACTICAL HINTS AND KINKS

How about the gadget you made or the trick you used to do your job better? Write us about it. Send a sketch too. You will be paid well for contributions.

Percussion Lance Speeds Tube Cleaning

INTERRUPTING a steady stream of compressed air or steam 1500 times a minute, a British-made percussion lance converts the steady flow into a pulsating force equal in cleaning effectiveness to a pressure of 2000 psi. Designed to remove soot, ash and clinker from tube surfaces in fire-tube or water-tube boilers as well as condensers, air preheaters and economizers, the lance's "live" force gives rapid, positive cleaning action.

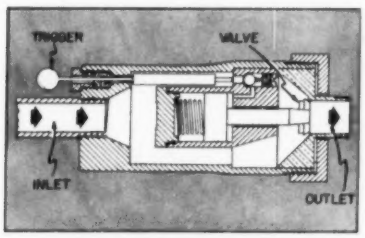
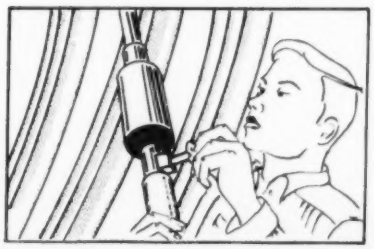


Fig. 1. Cross-section shows operation of valve which interrupts steam or flow 1500 times a min

Fig. 2. Sketch showing operator cleaning water tubes demonstrates ease of operation, light weight



Operation of the converting device, the percussion gun, is shown in Fig. 1. When the trigger or button is pressed, the valve at the outlet is caused to open and shut automatically nearly 1500 times a minute. This action converts compressed air or steam from an 80-psi line, for example, into repeated short blasts comparable to 1600-psi steady pressure. An incoming pressure of 60 to 150 psi is recommended. The lance, which weighs less than 6 lb, automatically shuts off incoming air or steam when the trigger is released.

Procedure for cleaning fire-tube boilers begins with connection of the gun to a steam or air line, and then affixing a suitable length lance to the outlet. Two short bursts of approximately 3 sec each will clean a tube. For water-tube boilers a short burst as near as possible to a deposit will clean tubes efficiently.

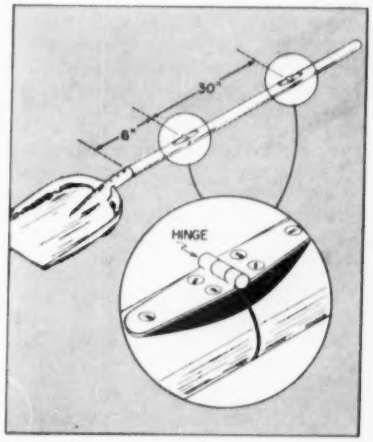
Lances up to 15-ft long for straight-through or sideways blasts, as well as many accessory lances, can be used.

This is the air gun referred to by John P. Hazell in his Letter to the Editors in the July issue, page 55.

An Educated Ash Scoop

By HARVEY C. HECKMAN

SEVERAL YEARS AGO we installed an Erie City 2 VL boiler in place of an old HRT boiler. This new boiler is about $8\frac{1}{2}$ ft wide and we had to set it with only 30 in. between it and the other HRT boiler. The Erie City boiler has two cleanout doors for the combustion chambers and since there is only a 30 in. aisle between the boilers it was quite a problem to clean out these chambers each week until I made some changes in a regular ash scoop.



Heckman's ash scoop showing how the hinges were installed for use in very cramped quarters

I took a No. 10 ash scoop with a 6 ft handle and put a 5 in. heavy strap hinge on top of the handle six inches from the ferrule of the shovel and another hinge 30 in. from that one. Then I sawed the handle in two at the hinges so that the shovel can be folded up. In using the shovel the fireman unfolds it as he shoves it into the ashes and folds up the handle as he brings out the ashes and carries them through the aisle to the wheelbarrow.

By doing it this way we do not have to wait until the boiler is cold enough for a man to crawl in there and remove the soot and fly ash.

Cut Your Belt Ends Square

By F. E. RILEY

AN ESSENTIAL REQUIREMENT for the smooth running of flat belts which have butt joints is that the belt edges, either side of the joint, should be perfectly parallel and straight. One way to achieve this is to be very careful

How to cut belt ends so they butt fair and square

to cut the belt ends as square as possible with the sides. Unfortunately, owing to the yielding nature of belting materials, the resulting joint does not come out perfectly square and the belt runs in a wavy manner as it passes over the pulleys. Apart from looking bad, the wavy running of a belt due to bad joints causes both edges to run with different tensions.

A method of cutting belt ends so that the above objections are avoided is shown in the illustration. The method eliminates the need for using squares and other accurate instruments. Instead of cutting one end of the belt at a time, both ends are cut together. The upper end of the belt is twisted, as shown, through 180 degrees so that the inside face of the belt is in contact with the outside. A cut taken through both belt ends while held in this position will ensure a perfect butt joint.

Improved Conveyor Belt Scraper Works Better

DURING THE PAST FEW MONTHS, several improvements have been made in the design of coal conveyor belt scrapers at Conners Creek, as described here by Jim Campbell, Boiler Room Engineer, The Detroit Edison Company in *Coal To Kilowatts*.

The credit for the improved design in belt scrapers belongs to Link Belt Company and credit for minor improvements to Ben Tolot and his Construction Department fellow workers. They refer to this job as — How to Clean A Magic Carpet.

The original, slightly inclined belt scrapers used at Conners Creek on both reversible and single directional belts are shown in Part A of Fig. 1. These double scrapers originally were used in 49 locations mostly near head and occasionally near tail pulleys. The unusual action of coal being removed by this type scraper is that it rolls under scraper belt and drops off the downstream side of scraper. Because of this rolling action, care must be taken to have sufficient space between hopper bottom on scraper nearest to it to allow coal to fall below. Also the angle of hopper bottom must be over 60 deg to allow scraped coal to slide more freely. This original double scraper is still used in 30 locations. Six of these latter locations are at either end of reversible conveyors. Minor chattering of scraper sometimes takes place upon these reversing belts.

Finally, the idea of greatly decreasing the angle of contact of the double belt scraper was tried on single directional belts as shown in Part B of Fig. 1. When these two scrapers were placed in contact with the conveyor belt where it passed over the pulley, scraping was improved. This decreased angle was, "A", found to be of great importance. The conveyor belt vibration ceased, resulting in a steadier and therefore more effective scraper pressure.

The following table shows the most efficient angle "A" of the scraper to tangent as shown in Part B of Fig. 1.

Pulley Diameter "D"—Inches	Angle "A" Degrees
24	3b
36	25
42	27
48	30

Due to interference of structural steel in one location, space was available to place only one of the above angled scrapers. So in this location, a single original type scraper was also placed with a pressure pulley rigidly mounted above return belt to prevent vibration. This combined application has worked satisfactorily.

Figure 2 shows enlarged view of the present belt scraper. Seven ply $\frac{3}{4}$ in. rubber for scrapers has been tried and no burning or excessive wear of conveyor belt has occurred. Reason for use of ply rubber was to afford greater scraper stiffness. Stops must be placed on the weight lever to prevent the scraper from flapping over as well as give a visual indication of the amount of scraper wear. Should the foregoing stops fail, the metal retaining plates shown in Fig. 2 must be short enough that they won't bind on the conveyor belt if scraper turned over. If retaining plates were too long and flapping over should occur, the belt could be ripped or burned.

The belt scraper shown in Fig. 2 will occasionally flap over even with proper stop setting. This is due to heating of scraper rubber causing it to soften and conform to pulley as shown in Fig. 3. Finally, scraper flaps over as shown and excessive heating can occur.

At present another improvement in scraper design is under trial to prevent the last malfunction. It is shown in Fig. 4. It consists of a white pine stiffener replacing the ply rubber stiffener. The white pine conducts heat away twice as rapidly as rubber in additicn to affording greater stiffness. Experience elsewhere with wood rubbing against rubber removes worry about wear of wood against belt when scraper wears down to wood stiffener. If this design works, it will be placed on all single directional conveyor belt scrapers.

The foregoing developments have been made already and no doubt further improvements will be made through inspection and further thought.

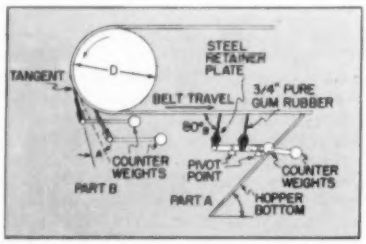


Fig. 1. Double scraper on one directional belt

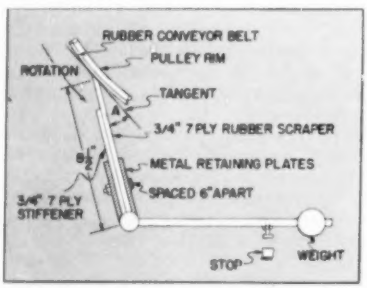


Fig. 2. Enlarged view of the present belt scraper

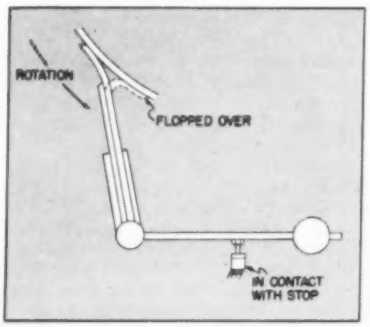


Fig. 3. Scraper softened by heat and flopped over

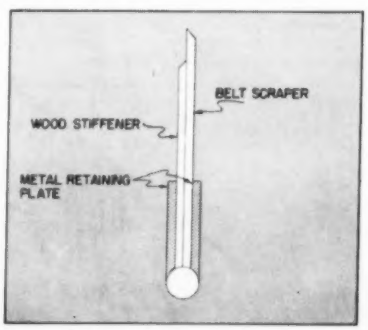


Fig. 4. Wood stiffener replacing rubber stiffener

What Happens to the Btu When You Mix Water and Steam (and Sometimes Ice)?

BASIC
Power Plant FIGURING
A Review for Old-Timers
A Must for Young-Timers

By WILLIAM H. ENGELMAN
Mechanical Engineer
Cleveland, Ohio

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THESE MIXTURES occur in various forms in refrigeration, air-conditioning, humidification, hot water tanks, boiler feedwater heating, process work, chemical plants. Various practical examples shown here illustrate the heat relations between them, the method and application of their solutions. No heat losses were considered and the answers are theoretical. The losses may be of so many different natures that it is necessary to treat each problem individually.

The general laws of thermodynamics cannot be readily applied in the case of mixtures. Water can be in the solid state, as ice, or in the liquid state, as water, and in the gaseous state, as vapor or steam. In mixing water, temperatures only are involved, but in the mixture of ice, water, wet steam, dry-saturated steam, and superheated steam, heat units (Btu) must be used. For ordinary purposes, and with water temperatures up to 212 F, one heat unit equals one degree temperature difference per pound.

Ice at 32 F (solid state) requires 144 Btu per lb to liquefy to water without change in temperature. If the ice is at a temperature below freezing, its temperature must first be raised to the point of liquefaction, which is at 32 F. This requires 0.5 Btu per lb per degree temperature difference below 32 F. To solidify one pound of water at 32 F to ice, without a change in temperature, requires 144 Btu.

To heat one pound of water from 32 F to the boiling point of 212 F (14.7 psia, the standard atmospheric pressure) requires 180.1 Btu. To evaporate one pound of water at 212 F with no change in temperature, requires 970.3 Btu; it is then called dry-saturated steam. See Fig. 1.

Heat requirements for each successive step to generate one pound of dry-saturated steam at standard atmospheric pressure from ice at − 40 F.

Ice from − 40 F to + 32 F requires 72 × 0.5	= 36.0	Btu/lb.
To liquefy the ice at 32 F	= 144.0	"
To heat the water from 32 F to 212 F	= 180.1	"
To evaporate the water at 212 F into steam	= 970.3	"
Enthalpy or total heat	= 1330.4	"

Data on heat values for water, dry-saturated and superheated steam can be obtained from *Thermodynamic Properties of Steam*, by Keenan and Keyes (John Wiley & Sons, Inc.).

Here are some of the problems in water-steam mixing that we shall explain.

1. Equal quantities of water at different temperatures.
2. Different quantities of water at different temperatures.
3. Different quantities and temperatures with final temperature known.
4. Ice at 32 F mixed with boiling water.
5. Ice at − 40 F mixed with boiling water.
6. Water at 32 F mixed with dry-saturated steam.
7. Water mixed with steam containing moisture (wet steam).
8. Water mixed with superheated steam.
9. 300 gpm of water per minute heated with wet steam.
10. Mixing of water and wet steam, final weight of mixture 30,000 lbs/hr.
11. Superheated steam reduced in pressure, then mixed with water and ice.

Fig. 1. Diagram showing number of Btu required to change 1 lb of ice at −40 F to saturated steam at 212 F, all at standard atmospheric pressure

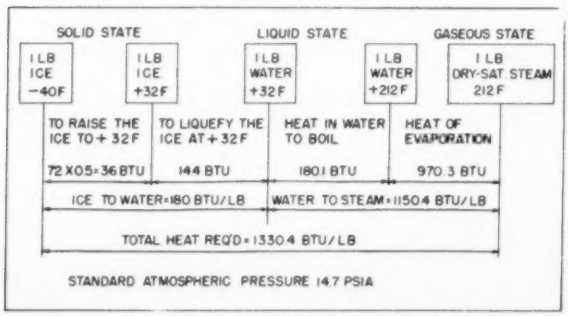
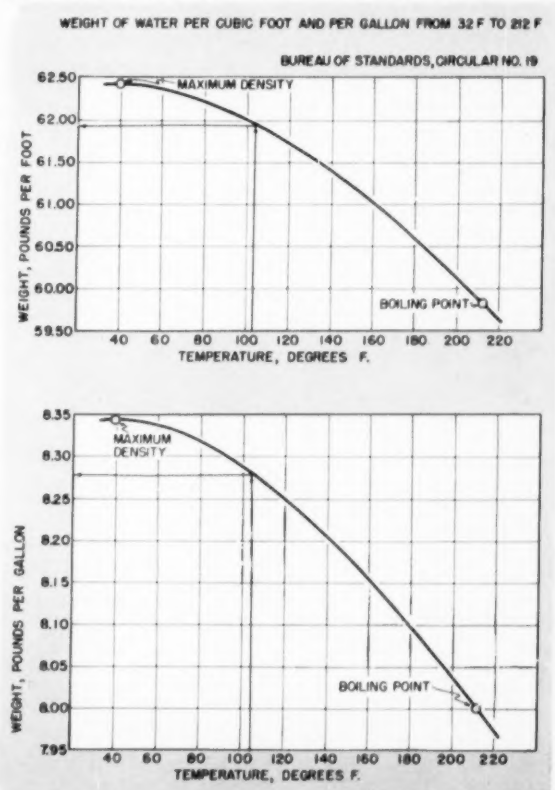

SOLID STATE
LIQUID STATE
GASEOUS STATE
1 LB ICE −40F
1 LB ICE +32F
1 LB WATER +32F
1 LB WATER +212F
1 LB DRY-SAT STEAM 212F
TO RAISE THE ICE TO + 32F
TO LIQUEFY THE ICE AT +32F
HEAT IN WATER TO BOIL
HEAT OF EVAPORATION
72 X 0.5 = 36 BTU
144 BTU
180.1 BTU
970.3 BTU
ICE TO WATER = 180 BTU/LB
WATER TO STEAM = 1150.4 BTU/LB
TOTAL HEAT REQ'D = 1330.4 BTU/LB
STANDARD ATMOSPHERIC PRESSURE 14.7 PSIA

Fig. 2. Curves showing weight of water per cubic foot and per gallon from temperatures 32 F to 212 F, for use in calculating water and steam mixtures



12. Mixing of ice, water, and dry-saturated steam.
13. Mixing of water, air, and steam at the given steam pressure.

For good understanding, all problems should be worked and sketches made showing the heat loss and gain.

Problems on the Mixing of Ice, Water, and Steam at Various Conditions.

Problem 1. 50 lb of water at 200 F are mixed with 50 lb of water at 100 F. What is the final temperature of the mixture?

Solution:

With equal weights the temperature is $\frac{200 + 100}{2} = 150$ F

Problem 2. 5 lb of water at 200 F are mixed with 10 lb of water at 116 F. What is the resulting temperature of the mixture?

Solution:

The heat loss equals the heat gain.
Weight of mixture is $5 + 10 = 15$ lb

$$\frac{(5 \times 200) + (10 \times 116)}{5 + 10} = \frac{1000 + 1160}{15} = 144 \text{ F}$$

The heat loss is $5(200 - 144) = 5 \times 56 = 280$ Btu
The heat gain is $10(144 - 116) = 10 \times 28 = 280$ Btu

Problem 3. 100 lb of water at 60 F are mixed with 200 pounds of an unknown temperature. The final temperature of the mixture is 150 F. What was the initial temperature of the 200 pounds of water?

$(100 + 200)150 - 100 \times 60 = 200$ X (X is the unknown temp.)

$$X = \frac{300 \times 150 - 100 \times 60}{200} = \frac{45{,}000 - 6{,}000}{200} = 195 \text{ F}$$

Check: Gain versus loss: $100(150 - 60) = 200(195 - 150)$
$100 \times 90 = 200 \times 45$
$9{,}000 = 9{,}000$

Problem 4. Two pounds of boiling water at standard atmospheric pressure are mixed with one pound of ice at 32 F. Find the temperature of the mixture.

Solution:

The mixture is made of material in different condition, a liquid and a solid, therefore heat units or Btu must be used. The base line is 32 F, because ice at 32 F requires 144 Btu per pound to liquefy with no change in temperature.

Heat in 2 pounds of water is $2(212 - 32) = 360$ Btu
Heat to convert ice to water at 32 F $= 144$ Btu
Available heat for the 3 pound mixture $= 216$ Btu

$216/3 = 72$ Btu per pound which is also a 72 F rise
Final temperature of mixture is $32 + 72 = 104$ F

Check: $2(212 - 104) = 1(144 + 104 - 32)$
$216 = 216$

Problem 5. A pound of ice at -40 F is mixed with two lb of boiling water. The barometer reading is 29.92 in. Hg. Find the resulting temperature.

Solution:

Ice from -40 to $+32$ F requires $72 \times 0.5 = 36$ Btu/lb
The heat of liquefaction at 32 F requires 144 Btu/lb
Total heat, ice to water at 32 F requires 180 Btu/lb

Heat in 2 pounds of water is $2(212 - 32) = 360$ Btu
Heat used, converting ice to water $= 180$ Btu
Available heat for the 3 pound mixture is 180 Btu

and 180/3 is 60 Btu per pound which is a 60 F rise in temp.
Final temperature of mixture is $60 + 32 = 92$ F

Check: $\frac{2(212 - 92)}{240} = \frac{1(36 + 144 + 92 - 32)}{240}$

Problem 6. Ten lb of water at 32 F are heated with one lb of dry-saturated steam at standard atmospheric pressure. Find the resulting temperature.

Solution:

Heat in 1 lb of dry steam above 32 F is 1150.4 Btu
Weight of the mixture is $10 + 1$ is 11 lb
1150.4/11 is 104.6 Btu or 104.6 F rise
Final temperature is $104.6 + 32$ is 136.6 F

Problem 7. Ten lb of water at 32 F are heated with one lb of steam at atmospheric pressure and 10 per cent moisture. Find final temperature.

Solution:

The steam contains—Heat of the liquid . . . . . = 180.1 Btu
Heat of evaporation is 0.9×970.3 . . . . . = 873.3 Btu
Total heat in steam . . . . . = 1053.4 Btu

Weight of the mixture is $10 + 1$ is 11 lb
1053.4/11 is 95.8 Btu or 95.8 F rise
Final temperature is $95.8 + 32$ is 127.8 F

Problem 8. Ten lb of water at 72 F are heated with one lb of superheated steam at 14.7 psia and a total temperature of 400 F. What is the final temperature of the mixture?

Solution:

From steam table—Total heat above 32 F is 1239.9 Btu
$72 - 32$ is 40.0 Btu
Available heat for the 11 lb mixture is 1199.9 Btu
1199.9/11 is 109.1 Btu or 109.1 F rise
Temperature of mixture is $109.1 + 72$ is 181.1 F

Problem 9. A hot water heater is required to heat 300 gal of water per minute from an initial temperature of 60 F to a final temperature of 180 F. The heating stem has a quality of 90 per cent and enters the heater at 5.3 psig. How many pounds of steam does the heater require per minute?

Solution:

$300 \times 8.333 = 2{,}500$ lb water per min
$180 - 60 = 120$ Btu per lb required
$2{,}500 \times 120 = 300{,}000$ Btu per min. taken up

From Keenan's Steam Table, Part 2, Page 35:
$5.3 + 14.7 = 20$ psia steam pressure.
$h_f + X\, h_{fg} = 196.2 + .9 \times 960.1 = 1060.3$ Btu/lb
Available heat is $1060.3 - 180 \times 32 = 912.3$ Btu
Steam required is $300{,}000/912.3 = 329$ lb per min

Note:

A gallon of water at 60 F = 8.333 lb, taken as 100.000%
and a gallon at 180 F = 8.10 lb, 97.204%

The increase in temperature reduces the weight by 2.796%
It takes 308.63 gal of water at 180 F for 2,500 lb
This must be considered where accurate measurements of water are required. It is much preferred to give the wieght of water in pounds and the temperature at which it is measured.

Problem 10. A feedwater heater is to supply 30,000 lb of water per hour from an initial of 62 F to a final of 212 F. The heating steam has a pressure of 22 psia and contains 9 per cent moisture. How many pounds of water must enter the heater per hour so that the mixture will make exactly 30,000 lb

Solution:

Heat in steam is $201.33 + .91 \times 956.8 = 1072$ Btu/lb.
Available heat is $1072 - 212 + 32 = 892$ Btu/lb
$892/(212 - 62) = 5.9466$ lb of water per lb of steam

Check:

Mixture is $1 + 5.9466 = 6.9466$ lb
$30{,}000/6.9466 = 4318.6$ lb of steam
$4318.6 \times 5.9466 = 25681.4$ lb of water
30000.0 lb of mixture

Problem 11. 100 lb of steam at 270 psia and 600 F are reduced to 33 psia through a reducing valve. The steam is then mixed with 70 lb of water at 60 F and 30 lb of ice at 4 F. The mixture takes place at 33 psia. Find the resulting temperature and condition.

Solution:

Ice from 4 F to 32 F is $30 \times 0.5(32 - 4) = 420$ Btu
To liquefy the ice at 32 F is $30 \times 144 = 4{,}320$ Btu
To raise the water from 32 F is $30 \times 224.41 = 6{,}732.3$ Btu
Total heat required by the ice $= 11{,}472.3$ Btu
To heat 70 lb water is $70(224.41 - 28) = 13{,}748.7$ Btu
Total = 25,221.0 Btu
Heat in steam is $100(1317.0 - 224.41) = 109{,}259.0$ Btu
Heat used by ice and water $= 25{,}221.0$ Btu
Heat available above 255.84 F $= 84{,}038.0$ Btu
$84{,}038/1092.59 = 76.92$ lb dry-sat. steam at 33 psia
$200 - 76.92 = 123.08$ lb of water at 255.84 F

Note:

In this problem not all the steam is condensed, therefore the final temperature of the mixture is that of the boiling point at 33 psia, which is 255.84 F with a corresponding heat content of 224.41 Btu per lb. The Btu content in the steam at the reduced pressure is the same as that of the initial pressure. Consult the steam table for these values.

Problem 12. What is the final temperature in mixing 15 lb of ice at 10 F, 30 lb of water at 72 F, and 3 lb of dry-saturated steam at 14.7 psia. The mixture takes place at atmospheric pressure.

Solution:

Ice from 10 to 32 F = $15 \times 0.5(32 - 10)$	= 165
Heat to liquefy ice at 32 F = 15×144	= 2160
Heat, ice to water	= 2325 Btu
Heat in water at 72 F = $30 \times (72 - 32)$	= 1200
Heat in steam at 14.7 psia = 3×1150.4	= 3451.2
	4651.1 Btu
Heat absorbed by the ice	= 2325.0
Available heat for the 48 lb mixture	= 2326.2 Btu

Temperature rise will be 2326.2/48 = 48.5 F
Final temperature of mixture is 32 + 48.5 = 80.5 F

Problem 13. 30 lb of water at 52 F and 40 lb of air at 92 F are mixed with 20 lb of steam at 77 psia and of 95 per cent quality. The mixture takes place at the steam pressure. Find the resulting temperature and condition of the mixture. Specific heat of air is 0.24 Btu per lb, steam temperature at 77 psia is 309.4 F, heat of the water h_f is 279.3 Btu and the heat of evaporation h_{fg} = 903.1 Btu.

Note:
Not all the steam will be condensed, hence, the point of evaporation should be taken as the base.

Solution:

Heat to raise the water is 30(279.3 − 52 + 32)	= 7,779 Btu
Heat to raise air is $40 \times .24(309.4 - 92 + 32)$	= 2,394 Btu
Total	= 10,173 Btu
Heat of evaporation in steam is $20 \times .95 \times 903.1$	= 17,161 Btu
Deduct heat in water and air	= 10,173 Btu
Heat available for evaporation of water is	6,988 Btu

6,988/903.1 = 7.74 lb of dry-sat. steam
40.00 " of air
42.26 " of water
90.00 " of mixture

Questions and Answers

Your fellow engineers will answer your power engineering questions. You answer theirs, get paid well. Simple? Effective? Why don't you try it?

Question No. 505

How Much Steam to Heat Molasses?

1 — How much steam capacity — either in pounds per hour or in boiler horsepower — will I need to heat 500 tons of molasses from 50 F to 100 F in 10 hours? Boiler is to operate at 125 psig. I would use iron pipe heating coils submerged in the molasses. The molasses will not be agitated, will just have natural circulation.

2 — How many square feet of heating surface would I need in the heating coils?

Kenmore, N. Y. V. G.

Editor's Note: — There was discussion of pumping molasses in our issues of August and December, 1949, also on burning molasses as a fuel in the December 1949 and March 1950 issues. But nothing was said there about the specific heat of molasses nor other characteristics except the viscosity, which was given by W. E. Worcester.

Answer No. 504

What Changes Are Needed to Drop Heating Steam from 125 psi to 15 psi?

LW raises these questions — What changes are required for the safety valves and the non-return valves when making a conversion on two 150 hp heating boilers from operation at 125 psi to 15 psi steam pressure and also, is a vacuum system required for the condensate that is now being returned by gravity?

As H. B. Wayne Sees It—

The boiler is fired by an underfeed stoker, but there aren't any flow meters, draft gages or CO_2 meters installed for determining boiler performance. When changing to 15 psi operation, it will be necessary to change the firing rate of the stoker or else the safety valves will be popping continuously. It is suggested LW consider installation of a three element combustion control system to regulate feed water, fuel and air to maintain proper firing rates. Cost for a simple control system may more than offset the inefficient firing of the boiler and the manual attention required when firing without it.

Since the boiler is to operate at 15 psi it will be necessary to change the setting of the safety valves. A 150 hp boiler has a steam output of approximately 5000 lb per hr. For a boiler having a rating of 5000 lb per hr and an operating pressure of 15 psi, LW may be able to use the same valve body but change the orifice size. The safety valve manufacturer will recommend the proper size for the new operating conditions. As a preliminary step, LW may calculate the required orifice size by the following formula: $A = Q/50P$; where A is equal to required orifice area in square inches, Q equals steam flow in lb per hr, and P is equal to valve set pressure + over pressure + 14.7 psia.

LW does not describe the type of non-return valves presently installed. With the boiler outlet pressure reduced to 15 psi and the headers operating at approximately the same pressure, the net differential pressure across the valve seat is approximately the same. However, the total force acting on the underside of the valve disk due to the steam pressure may not be great enough to overcome the combined weight of the disk and stem, and the resistance from friction of the valve stem. Therefore it is suggested LW discuss this matter with the valve manufacturer and make any necessary adjustments recommended by same.

LW should consult the heating boiler section of the ASME Boiler Code, state and local laws and have approval from the insurance underwriter when making this conversion.

LW does not describe the physical layout of the heating system such as length of runs, static heat, etc. If the combined pressure drop of the steam and condensate exceeds the available boiler pressure, installation of a vacuum system will be required.

The Fritzsche formula may be used for calculating the steam pressure drop. This formula is: $P = 0.8\,LF^{1.85}/Yd^{4.87}$; where P is equal to steam pressure drop in psi, L equals total equivalent pipe length in feet, F equals steam flow in lb per second, Y equals average steam density in lb per cu ft, and d equals pipe inside diameter in inches.

For the condensate returns, the pressure drop may be calculated by the Saph and Shoder formula which is as follows:

$$P = W^{1.86}/15.13 \times 10^5 \times d^5;$$

where P equals pressure drop in psi per 100 ft, W equals water flow in lb per hr, d equals pipe inside diameter in inches.

Use of a vacuum system should be avoided whenever possible because it is difficult to maintain tight pipe joints required for keeping vacuum. Installation of a vacuum system requires a special type of pump designed for this type of service, which requires more attention than conventional pressure pumps.

For determining boiler output at different heating loads, it is suggested LW install a steam flow meter in the boiler outlet piping. The meter body may be the plate orifice type or the venturi type. The venturi type costs more, but gives less permanent pressure drop and is more accurate. Meter may be indicating or recorder type. If LW installs a three element combustion control system as suggested above, the steam flow meter will be included as part of this system.

Installation of instruments permits operation at higher efficiency. Study of instrument records aids the operator to determine when the unit

should be taken off the line for maintenance and repairs.

Brooklyn, N. Y. H. B. WAYNE

Moulton Comments

To start with we can assume that the heating system will take the same amount of heat at 15 lb as before. Since steam at 15 lb contains less heat per lb than at 125 lb, it will take a greater weight of steam. The density of steam at 15 lb is less the volume will be greater than at 125 lb. This may call for larger steam mains, depending upon conditions of course, as to whether they are now fully loaded or only partly loaded.

Comparing the enthalpys or total heat of steam at 125 lb and 15 lb we find:

Steam at 125 lb gage saturated has enthalpy of 1192.4 Btu per lb

Steam at 15 lb gage saturated has an enthalpy of 1163.7 Btu per lb

As boiler horsepower is taken as 33479 Btu per hr the steaming rate of a 150 hp boiler would be: $33479 \times 150/1192.4$ or 4200 lb per hr. At 15 lb it would be $33479 \times 150/1163.7$ or 4400 lb per hr.

From LW's description I would say his boilers are 6×18 ft with a grate surface of about 36 sp ft or equivalent. Massachusetts State Boiler Rules give the following data applicable to this problem; for safety valves with bevel seats, steam pressure 100 to 150 lb with a grate area of 39.5 sq ft requires a safety valve area of 9.6211 sq in., equal to one 3½ in. valve.

From 0 to 25 lb and 40 sq ft of grate surface requires a safety valve area of 15.9040 sq in. equal to one 4½ in. valve. The area of two 3½ in. valves is 19.2422 sq in. which is more than the area required. The safety valve areas are based on the formula: $A = W \times 70/P \times 11$; where A area of direct spring loaded safety valve in sq in. per sq ft of grate surface; W = weight of water evaporated per sq ft of grate surface per second; P = pressure (absolute) at which safety valve is set to blow.

The pressure drop through a six in. combination stop and non-return valve is about the same as that through a six in. angle valve or about 100 ft of straight pipe. Length of branch pipe is not given, but under ordinary conditions should not be over 50 ft and is usually less but let's take the total resistance as equivalent to 200 ft of straight pipe.

From a chart of pressure drop in steam pipes by Unwins formula and checked by Fritzches formula, we find that for a steam flow of 4200 lb per hr at 125 lb gage saturated through a six in. schedule 40 pipe is 0.04 lb per 100 ft of pipe. Then the pressure drop for 200 ft is $0.04 \times 2 = 0.08$ lb.

By the same method the pressure drop through a six in. schedule 40 pipe with a steam flow of 4400 lb per hr at 15 lb gage saturated is 0.22 lb per 100 ft or 0.44 for 200 ft.

Here we see that the pressure drop between boiler and header is small. So it would seem that the six in. non-return valve would be large enough to prevent excessive drop between boiler and header. As to whether it would operate properly under the lower pressure is a matter to take up with the makers, insurance company or state boiler rules.

The two 3½ in. safety valves have sufficient area, but of course the 125 lb springs would have to be replaced by two 15 lb springs. But again state or insurance requirements might demand new 15 lb valves.

With the reduced pressure it would be advisable to change the entire heating system to vacuum as it would allow a greater pressure drop in steam mains to points of distribution. This means motor driven pumps as steam pumps could not be used.

Pittsfield, Mass. ALBERT H. MOULTON

According to LaRocco—

I assume LW has two boilers in such condition they will carry 150 lb pressure and reducing to 15 lb is voluntary. Then the safety valve or valves shall have a capacity great enough to discharge all the steam generated by the boiler without allowing the pressure to rise more than six per cent above the pressure at which the valve is set.

If the boilers are no longer fit to operate at 150 lb pressure then in no case shall the pressure be allowed to rise six per cent above maximum working pressure of the boiler.

The maximum steaming capacity of the boiler will be based on the capacity of the fuel burning equipment, on the air supply, draft, etc. Use the following formula: $W = C \times H \times 0.75/1100$; where W = weight of steam generated per hour in lb, 6 = total weight or volume of fuel burned per hour at time of forcing in lb or cu ft determined by test, H = heat of combustion of fuel in Btu per lb or cu ft.

The total capacity of safety valves must be equal or greater than W. No change is necessary regarding outlet valves. The vacuum system and gravity system will continue to operate as usual, but a complete vacuum system would be desirable.

Chicago, Ill. BERNARD J. LAROCCO

Eckert Says—

To convert LW's plant to 15 lb from 125 lb operating pressure is not very difficult or expensive. First assuming the boilers are capable of 5000 lb steam production at 125 lb, a conversion to 15 lb will not materially affect the steam producing capability of the boiler in Btu rating.

Roughly, the boiler produces about 5000×1075 Btu or 6375 Btu at the boiler nozzle, assuming 120 F feedwater. So it will be necessary to install safety valves of at least that size. Using the ASME heating code, determination, divide 6,375,000 Btu by 1000, and we arrive at 6375 lb of steam relieving capacity for the safety valves. You say you have two 3½ in. nozzles on the boiler for safety valves. In checking a catalog of a prominent piping and valve supplier, I find that they have a 2½ in. safety valve, National Board approved, set at 15 psi with a rated relieving capacity of 3485 lb capacity. Therefore two of these 2½ in. valves will give you 6970 lb relief capacity which is adequate, provided our basic assumption was correct.

Next LW states the heating pressure on the system to be five psi. I cannot see where he would have any particular difficulty in heating if he will set the boiler pressure regulators at four to six lb unless experience makes it necessary to increase this pressure setting to a higher one in order to get proper pressure at the heat header. Set the pressure regulator on the header.

As to changing over to a vacuum system, this might to some extent complicate things, but if the systems you now have are working satisfactorily why not let them alone until such a time as maintenance demands a change and then consider a hot water system? High temperature if possible.

As to measurement of boiler load you can procure flowmeters from good firms or you can if the system is tight, measure condensate from the system with a meter. You can also measure with a meter, the feedwater to the boiler provided you have no gravity returns direct to the boiler.

The non-return valves may be discarded and ordinary valves of outside screw and yoke type installed to cut the boiler off when it is not needed. However, this can only be done if the returns from the system are made direct to the boiler. A stop valve must be installed on the return line also.

In refitting the boiler I would suggest LW consult his boiler inspector and a good heating engineer to get the best results.

Mt. Vernon, Ill. ALBERT R. ECKERT

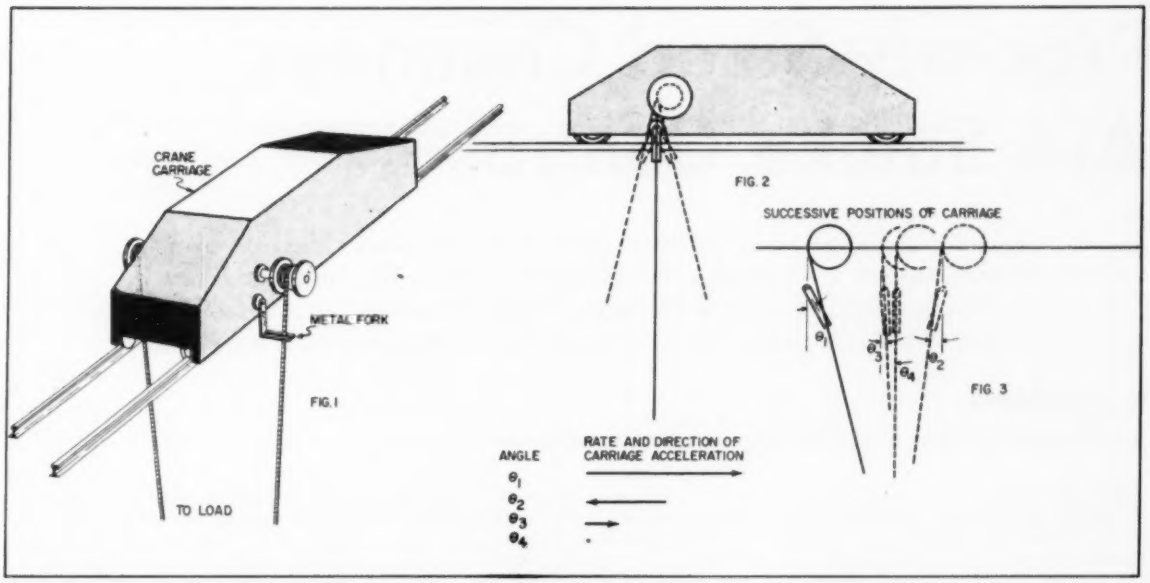
Davis States—

In answer to LW I would say that he would be required to make major alteration in his steam lines as far as and including the reducing valves. This would probably include new boiler thimbles, stop valves and steam mains as the present equipment would be insufficient to carry the steam where it is needed.

The Insurance Inspector or State Inspector would also probably require more safety valves or larger capacity.

So far as the heating lines are concerned, I see no reason to change them if they are giving satisfactory service as they are. With sufficiently large lines to carry the steam to the reducing valves and the reducing valves changed to allow sufficient steam to pass through under the lower pressure, your conditions beyond these valves should remain as at present.

Tacoma, Wash. CLYDE E. DAVIS



Figs. 1 to 3. General arrangement of Argonne's anti-swing crane and diagrams to show how it works. Fig. 1. General view of crane, showing fork that produces electrical signal of load swing. Fig. 2. As crane cable starts to swing in one direction or other, it moves fork, turning crank arm, which is connected into carriage drive control circuit. Fig. 3. Signal from fork causes carriage to move slightly in direction of swing. If this is too far, the cable moves the fork the other way, reversing carriage movement until carriage is directly over load, and stopping the swing. The load usually stops swinging in one or two cycles

Anti-Swing Crane Increases Safety and Accuracy

ANTI-SWING CRANE with anti-creep variable-speed hoisting has been developed by engineers of the Remote Control Engineering Division of Argonne National Laboratory, a research and development laboratory operated by the University of Chicago for the U. S. Atomic Energy Commission.

The new development, conceived by Associate Division Director Raymond C. Goertz, inventor of the master-slave manipulator,* offers promise of increased safety and accuracy in materials handling. In a laboratory model of the crane, pendulum-like swinging of the hook and load has been reduced to a minimum while vertical creeping of the load has been completely eliminated. With this type of crane control, radioactive and/or thermally hot materials can be transported without the necessity of having personnel to guide and steady the hook and load.

In normal crane operations, the following takes place: the crane with its load begins to move in a horizontal direction. As the movement starts, the load being carried on the hook tends to swing in the opposite direction. When the crane has reached its destination and is stopped, the load, now possessing momentum, continues its movement in the direction in which it has just traveled. When it has swung as far as possible, the load returns to the vertical position and then swings in the opposite direction. This pendulous swinging continues for some time. Skilled crane operators can, however, reduce the magnitude of the swing by maneuvering the crane carriage.

In the Argonne-developed model, the normal carriage drive has been replaced with a servomechanism, which moves the carriage in accordance with electric signals. In operation the following happens: the crane operator determines the direction in which he wishes the crane to travel and turns a control knob on the instrument panel. The crane automatically moves in the direction chosen and, while doing so, transmits electric signals to the servomechanism regarding its position, speed of movement, and amount of swing of its load. The servomechanism adds these positive and negative signals to that which was placed into the servomechanism when the crane operator turned the control knob. A summation of the signals equaling zero means that the crane has reached its desired position. Deviations from a total of zero cause the crane carriage to move forward or backward.

An electric signal that indicates the degree of swing of the load causes a slight movement of the crane's carriage in the direction of the swing. This action allows the load to dissipate its oscillatory energy into the carriage and, as a result, the load stops swinging within one or two cycles. This anti-swing action is shown in Figs. 1, 2 and 3.

The crane is also equipped with a continuously-variable-speed drive for hoisting operations.

* A manipulative device that effectively reproduces the major motions of the human hand. It is used at Argonne and at other AEC laboratories to facilitate the handling of extremely radioactive materials.

EDITOR'S NOTE

IT WOULD SEEM that here is an idea, freely available to everyone, that power engineers and manufacturers of materials-handling equipment might investigate from the practical user's angle.

Dr. Harvard L. Hull, Director of the Remote Control Engineering Division, commented on the new crane as follows: "A crane of this type should prove to be of great value to those industries and operations in which materials handling is a prime concern. It has been developed to the extent that interested industrial firms should be able to carry this program further and to perfect a very good full-scale crane embodying the unique features of this model. We hope that industry will avail itself of this opportunity."

If you are interested in finding out more about the anti-swing crane, write The Editors, POWER ENGINEERING, 110 South Dearborn St., Chicago 3, Ill., or use the post card elsewhere in this issue.

Properly-Sized Chimneys Aid Smoke Control

Natural-draft chimney must create required draft and deliver maximum quantity of gas passed to it for disposal. It is essentially a pump. This article shows how its performance depends on some 14 factors. Along with overfire air, properly-sized chimney contributes greatly to prevention of smoke in the operation of power plants

By J. G. MINGLE

Superintendent, Bureau of Air Pollution Prevention, City of Indianapolis

PRESUPPOSING a properly designed and proportioned furnace in a fuel-burning system, two plant auxiliaries can contribute greatly to the prevention of unlawful smoke in the operation of power plants and steam plants, especially those burning coal. One is an overfire air system and the other a properly-designed chimney. Since the two main functions of a natural-draft chimney are to create draft and deliver gases, it is of paramount importance that the structure will be of such dimensions that it will produce the draft necessary to overcome all of the resistances throughout the path of the gases when delivering the maximum quantity of gases passed on to it for disposal. Chimney sizes have been selected without too much attention being paid to this requirement, most sizes being chosen from a table based only on boiler horsepowers. This article, rewritten from a paper by the writer before the 45th Annual Meeting of the Air Pollution and Smoke Prevention Association of America, in 1952, explains the performance of natural-draft chimneys and develops a table of chimney sizes based on sound reasoning.

Chimney Performance

In determining the size of a natural draft chimney, its performance must first be investigated in order to determine certain factors which affect its height and diameter. The functioning of a chimney in producing draft and delivering gases is comparable to that of a centrifugal fan or a centrifugal pump in creating pressure and delivering fluids. The performance of these pressure transformers is interpreted by means of a set of curves, termed performance characteristics, which are plottings on cross-section paper of the work done and results accomplished over the entire range of their operation. The characteristics or curves include essentially: (1) a head- or draft-delivery characteristic which shows the relation between the head, pressure, or draft developed and quantity of fluid delivered, (2) a horsepower characteristic which shows the power or energy involved in effecting the head-delivery performance, and (3) an efficiency characteristic which shows the relation of the energy output and energy input in the operation of the unit. Data for the construction of such curves for fans and pumps are obtained in testing laboratory. Performance characteristics for natural draft chimneys are constructed from the known data under which they operate, most of the required information being easily obtainable.

Draft-delivery Relationship

The draft-delivery relationship or performance of a natural draft chimney is expressed by equation (1), Table I.

This equation, termed the draft-delivery equation, expresses the relation between the draft produced by the chimney which is available for overcoming the total dynamic draft of the external system and the delivery of the chimney as measured by the quantity of gases generated by the fuel-burning system and passed on to the chimney for disposal. The first group of terms of the right hand member expresses the theoretical draft produced by the chimney and the second group the draft loss due to friction in the chimney.

As a typical example in the application of this equation, let it be assumed that a natural draft chimney 238 ft high and 10.22 ft minimum internal diameter is operating in a steam plant at an elevation of 800 ft above sea level and that the average chimney-gas temperature is 500 F, atmospheric temperature 68 F, chimney gas specific weight 0.0772 lb per cu ft under standard conditions, and friction coefficient for sooted surfaces 0.018. Substituting the proper values in equation (1) and reducing, we get equation (2).

By assuming successive values for W^2_g and plotting the corresponding values for D_a, the draft-delivery characteristic shown in Fig. 1 is constructed. The draft-delivery curve originates at a theoretical draft intensity of 1.45 in. w g (inches water gage) and decreases as the quantity of gases flowing increases. The decreased draft intensity, termed the available draft, must be equal to at least the total dynamic draft of the external system, otherwise there would be no gas flow. Curves may

Table showing equations for analyzing natural-draft chimney performance, as given in the text

$$D_a = 3.396\,H\,B_o\left(\frac{w_a}{T_a}-\frac{w_o}{T_o}\right)-\frac{0.0011\,f\,L\,T_o\,W_g^2}{w_o\,B_o\,D^5} \qquad (1)$$

where D_a = available draft of chimney, in w g,
H = height of chimney above bottom of breeching opening, ft,
B_o = atmospheric pressure corresponding to altitude of the plant, in. Hg,
w_a = specific weight of the atmosphere under standard conditions of 68 F and sea level elevation (29.92 in. Hg), lb per cu ft,
w_o = specific weight of the chimney gases under the same standard conditions, lb per cu ft,
T_a = atmospheric temperature, deg F abs,
T_o = average chimney-gas temperature, deg F abs,
f = friction coefficient for sooted surfaces, without units,
L = length of friction duct of chimney, ft,
W_g = delivery of chimney, lb of gases per sec,
D = minimum internal diameter of chimney, ft.

$$D_a = 1.45 - 0.0000181\,W_g^2 \qquad (2)$$

Total dynamic draft of a fuel-burning system is made up of: (1) the draft loss due to velocity, (h_v); (2) the draft loss due to an abrupt contraction of a duct, (h_c); (3) the draft loss due to an abrupt enlargement of a duct, (h_e); (4) the draft loss due to elbows, (h_{el}); (5) the draft loss due to friction in the breeching, (h_{br}); (6) the draft loss through the fuel bed, (h_{fb}); (7) the draft loss through the boiler and setting, (h_b); and (8) the draft loss through recuperators, (h_r). Other losses, such as those through fly ash collecting systems, spray systems, baffle systems, etc., should be included when they are installed in the path of the flowing gases. Each loss is a function of the velocity head and all are expressed in terms of inches of water gage. Hence, if D_a is the available draft, D_{td} the theoretical draft, h_f the draft loss due to friction in the chimney, and D_{tdh} the total dynamic draft of the external system, then the general draft equation is given by:

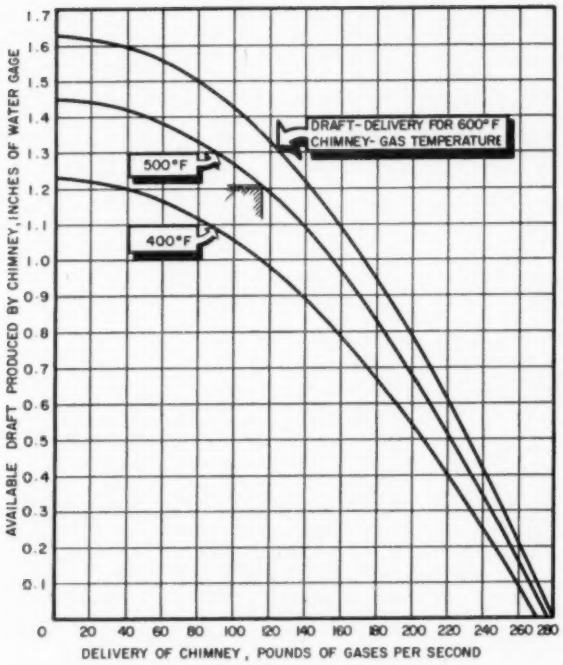
$$D_a = D_{td} - h_f = D_{tdh} = h_v + h_c + h_e + h_{el} + h_{br} + h_{fb} + h_b + h_r \qquad (3)$$

$$D_v = 0.2688\sqrt{\frac{W_g\,T_o}{w_o\,B_o\,V}} \qquad (4)$$

$$H_r = \frac{D_{tdh}}{3.396\,B_o\left(\frac{w_a}{T_a}-\frac{w_o}{T_o}\right)-\frac{0.21\,f\,w_o\,B_o\,V^2}{D_r\,T_o}} \qquad (5)$$

$$D_r = 59.94\sqrt{\frac{1}{V}} \qquad (6)$$

$$H_r = \frac{1.21}{0.006113-0.0000001471\,V^{5/2}} \qquad (7)$$


AVAILABLE DRAFT PRODUCED BY CHIMNEY, INCHES OF WATER GAGE
DRAFT-DELIVERY FOR 600°F CHIMNEY-GAS TEMPERATURE
500°F
400°F
DELIVERY OF CHIMNEY, POUNDS OF GASES PER SECOND

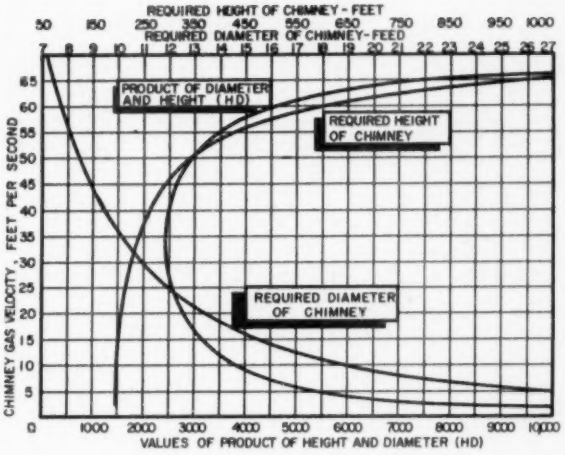

REQUIRED HEIGHT OF CHIMNEY - FEET
REQUIRED DIAMETER OF CHIMNEY - FEED
PRODUCT OF DIAMETER AND HEIGHT (HD)
REQUIRED HEIGHT OF CHIMNEY
REQUIRED DIAMETER OF CHIMNEY
CHIMNEY GAS VELOCITY, FEET PER SECOND
VALUES OF PRODUCT OF HEIGHT AND DIAMETER (HD)

Fig. 1.—Left. Typical performance characteristics for a 238-ft. by 10-ft. 3-in. natural draft chimney. Calculations for performance are as given in the table

Fig. 2.—Above. Variation in required diameter and required height of chimney and also the product of diameter and height (HD) with chimney-gas velocity

also be shown for the horsepower (not boiler horsepower) and efficiency of the chimney but, contrary to centrifugal pump and fan characteristics, neither are of much practical use, although it is of passing interest to note that, due to the poor utilization of the low-grade heat energy in the chimney gases, the efficiency of a natural draft chimney is extremely low. Now let us see how we can interpret the performance data.

Draft-delivery Curve

In Fig. 1, for a chimney-gas temperature of 500 F, the chimney will deliver 116 lb of gases per second and create 1.21 in. water gage (w g) available draft to overcome a total dynamic draft of the same intensity, these being the conditions for which the chimney size was computed. If, for example, the total dynamic draft is 1.30 in. w g, the stack will deliver only 88 lb of gases per second. On the other hand, if 140 lb of gases per second are generated and passed on to the chimney for delivery, it will produce only 1.10 in. w g of available draft to overcome a total dynamic draft of only the same intensity, and the stack is said to be "over-loaded". Thus is emphasized the importance of accurate calculations and careful assumptions of both the total dynamic draft and the maximum quantity of gases to be delivered in determining the size of a new chimney.

Chimney-gas temperature greatly affects the chimney performance. If, for example, the chimney-gas temperature is only 400 F, the chimney will deliver only 30 lb of gases per sec against a total dynamic draft of 1.21 in. w g, or will create only 1.00 in. w g available draft for a delivery of 116 lb of gases per sec. However, for a chimney-gas temperature of 600 F, the stack will deliver 142 lb of gases per sec against a total dynamic draft of 1.21 in w g, or will create 1.35 in w g available draft for a delivery of 116 lb of gases per sec. Keen judgment should be exercised in selecting the proper chimney-gas temperature in determining the size of a new chimney.

Performance of a chimney varies with the atmospheric temperature. Whereas the available draft increases with the chimney-gas temperature, the opposite is true with the atmospheric temperature. This condition accounts for the fact that the draft of a chimney is always *better* during the winter season when the atmospheric temperature is lower than during the summer months. All other factors remaining constant, a chimney of a given size will create less available draft and deliver less gases at an elevation than at sea level. Hence, both the atmospheric temperature and the elevation of the plant should be taken into consideration in determining the size of a new stack.

Total Dynamic Draft

Total dynamic draft against which the chimney operates is made up of the total draft losses throughout the installation outside of the chimney itself and is equivalent to the total dynamic head, like that against which a centrifugal pump operates or the total dynamic pressure against which a centrifugal fan or blower works, the terms draft, head, and pressure being synonymous terms. As a matter of fact, a natural-draft chimney may be considered as a type of an air pump Equation (3) shows factors in total dynamic draft.

Evaluation of the various factors constituting total dynamic draft is necessarily somewhat complicated, particularly when the information is required for the determination of the size of a new chimney. For an existing plant, sufficient information is available that most of the draft losses can be easily calculated but in the case of a proposed plant it is necessary to make assumptions. Suffice it to state that the various draft losses should be calculated or obtained in much the same manner and to the same degree of accuracy as head losses are obtained for pumping units in waterworks projects.

Size of Chimney

Calculation of the required size in terms of minimum diameter and maximum height above the bottom of the breeching opening of a new chimney is somewhat of an involved process. It has been the custom to select a chimney size from a table of chimney sizes based on boiler horsepowers. The size of a new chimney should be calculated in the same careful manner as the size of a new centrifugal pump for a waterworks system or of a new centrifugal forced-draft or induced-draft fan for a power plant system.

There are 14 factors affecting the size of a chimney: (1) chimney-gas temperature, (2) atmospheric temperature, (3) barometric pressure corresponding to altitude, (4) friction coefficient, (5) diameter of chimney (affects the height), (6) draft loss due to velocity, (7) draft loss due to an abrupt contraction of a duct, (8) draft loss due to an abrupt enlargement of a duct, (9) draft loss due to elbows, (10) draft loss due to friction

(*Continued on page 119*)

OPERATING EXPERIENCE . . .

with Hydro-Plant Valves

By **WILLIAM G. WEBER,** Engineer
Design and Construction Division
Bureau of Reclamation
Denver, Colorado

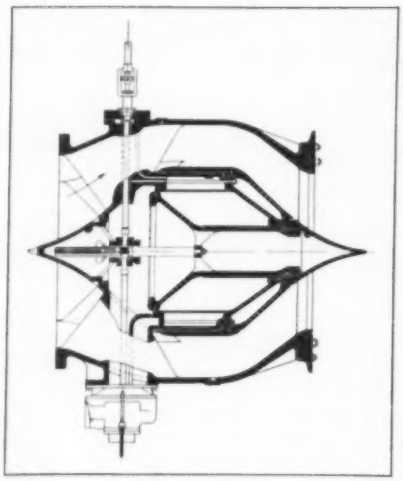


Fig. 1. Internal differential needle valve has water-passageway properties which may lead to pitting

Fig. 2. Extensive weld repairs on the throat of a needle valve necessary because of excessive pitting

Cylindrical or axial-travel type gates and valves are normally used to regulate outlet discharge in hydraulic structures. Here is what the Bureau of Reclamation has learned about their operation and maintenance

GATES AND VALVES of the cylindrical or axial-travel type are discussed in this article.* They are normally used for outlet discharge regulation in hydraulic structures built by the Bureau of Reclamation.

Needle valves of various designs are included in this group. Most needle valves are of the balanced type in which hydraulic cylinders for valve operation are built into the bodies. Normal operation of many of the earlier valves is accomplished through the admission of water at reservoir or supplementary pump pressure into the valve body for closing, or the removal of water from the body and creation of a partial vacuum by an eductor for opening. For example, the 60-in. balanced valves at Elephant Butte Dam, constructed by the Bureau in 1916, operate essentially in this manner. When the reservoir level is too low for valve operation, however, the needle is moved by a ram operated by hydraulic jacks which are supplied with pumped water. Occasionally the combined efforts of cylinder piston and ram have not been sufficient to open a valve, and additional force from a 100-ton jack applied to the nose of the needle is required to crack it loose from its seat.

Worn needle seats are a major cause of difficulty in starting valve motion, and seat repairs, accomplished by filling recessed areas with bronze weld metal and careful grinding, have been necessary. Excessive clearances around bull rings also make hydraulic operation uncertain — moderate amounts of water leak into or out of the body enclosure through the space between bull-ring grooves and body liners. As these valves tend to creep and are difficult to hold at a part-open position, they are maintained either fully opened or fully closed.

Valves subsequently developed by the Bureau are provided with a positive control device whereby a control valve in, or attached to, the main valve body is mechanically manipulated. These needle valves may also creep a short distance, but this motion either opens or closes the control valve correspondingly and a condition of equilibrium is soon reached.

Pitting of Valves

Many of the older needle valves, such as the one shown in Fig. 1, have water-passageway characteristics which cause water as it emerges from the valve to pass at high velocity through a region of expanding areas. Negative pressures, cavitation, and resultant pitting may be expected. At Arrowrock Dam, built in 1915, there has been a considerable amount of pitting due to cavitation in the discharge rings of the 58-in. balanced valves immediately downstream from the seats. This was true also, but to a lesser extent, on the upper- and under-sides of the needle cones in the planes of the gate guides where free entrance of water is blocked. The most severe pitting occurred on the discharge rings of the positive control valves of the upper tier. The pitting was so extensive that when repairs

*This is the second of three articles recently adapted by the author, especially for POWER ENGINEERING, from a paper before the National Conference on Industrial Hydraulics at Chicago in 1950. The first article covering cut-off type gates was published in the October issue, page 110.

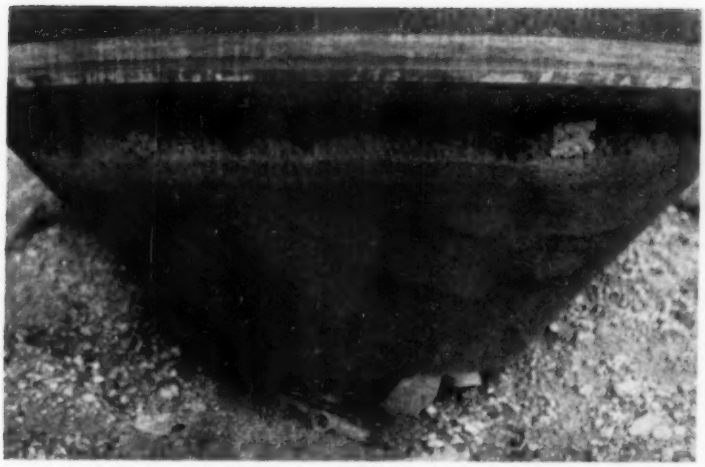


Fig. 3. As a result of cavitation, pitting may extend in varying degree around the needle as shown. A new needle has replaced this one, removed from one of the valves at Alamogordo Dam

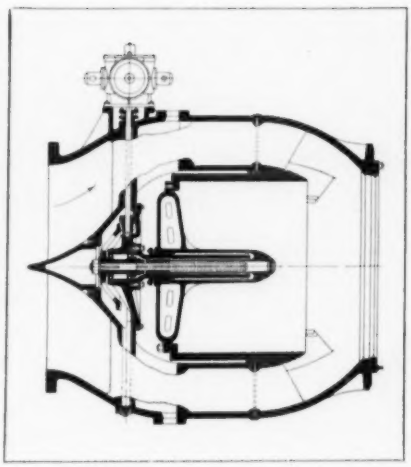


Fig. 4. Use of tube valves, which eliminate cone needle tip, helps alleviate pitting. Valve shown is 52-in.

were made the weld metal was required to be deposited all around the circumference for a distant of 24-in. downstream from the gate seats. This welding was done using mild steel rods. Beads were laid parallel with the outlet axes. As the beads were not ground smooth, the welded surfaces of the discharge rings present a rough outline as shown in Fig. 2. Except in the plane of the gate guides, where in a few valve areas up to about 1 sq ft required rewelding, relatively little subsequent damage has occurred. This damage is repaired as required as a part of annual maintenance work.

Figure 3 shows severe pitting on a needle removed from one of the valves at Alamogordo Dam a few years ago. This is not an uncommon effect of cavitation on these needle valves which have the slightly increasing orifice area from the seat to the downstream end of the valve. As a result of cavitation, pitting extends with varying degrees of intensity around the conical needle for several inches downstream from the seat ring. Pitting also has occurred on the body surfaces corresponding to the pitted areas on the needles. A new needle has replaced the one shown in Fig. 3 and is so shaped that, in place of an expanding waterway between needle cone and body, there is a slight choke or restriction; thus control is held at the end of the body. Since it was repaired, and except for difficulties with mud and scale, this valve has operated much better and cavitation pitting has correspondingly decreased.

Newer valves have been designed incorporating the revised needle contour. While these valves have been in service for a relatively short time, preliminary operating reports indicate that many of the difficulties resulting from cavitation have been eliminated.

Another approach to the solution of the problem of cavitation damage to the coned end of a needle valve is exemplified by the use of the tube valve in which such damage is prevented by the simple expedient of eliminating the cone needle tip. One of the 52-in. tube valves in outlets at Deer Creek Dam is shown in Fig. 4. Tube valves are powered either by hydraulic cylinders or by electric motors employing reduction gearing. Deer Creek tube valves, in service since 1941, have given satisfactory service, and except for some minor pitting on downstream ends at the central nut tubes, they show little evidence of cavitation. Other tube valves, however, tend to vibrate and show an objectionable irregularity in discharge pattern over a fairly wide range of part opening.

Hollow-Jet Valves

Presently favored and most recent of the cylindrical type of valves to be placed in service is the hollow-jet valve. This valve is motor-operated through a bevel gear and pinion and a screw. In contrast to the needle valve which is closed by a movement of the needle in the direction of flow, the hollow-jet needle closes by a movement against the flow. Holes in the valve cone provide a means of balancing pressures on both sides, and as a result, there is a varying but relatively small amount of power required to overcome resistance to needle travel. Water emerges from a valve in the form of a hollow cylinder that has little tendency to disperse and form spray until it has traveled some distance from the discharge orifice, regardless of the degree of valve opening.

In general, all free discharge from gates and valves causes a marked circulation of air in its vicinity. For this reason, when the discharge is in a tunnel or confined space, it is desirable and sometimes necessary that special air access passageways be provided separately from the manways and operating chambers. In this respect, the hollow-jet valves are perhaps more demanding than other valves; in addition to the air drawn along with the outer elements of the jet, there is a heavy demand for air in the central area. Air within the central area of the jet is probably a major factor in causing what appears to be more than usual disturbances in the stilling pool. These disturbances tend to be localized near the pool surface. In order to spread the agitation and energy dissipation to greater pool depths and to reduce the size of stilling pool required, the practice has been adopted of directing the valve discharges downward at angles varying from horizontal up to 30 deg.

None of the installed hollow-jet valves has been in service for a sufficient length of time to permit formation of a definite opinion of their reliability, but preliminary reports indicate that, once all mechanical difficulties are eliminated, they will be less difficult to maintain.

S.S. United States Is Fireproof

CHANCES THAT a boy will ever stand on a burning deck of the new *S.S. United States*, our latest and finest passenger liner, seem to be extremely remote In this ship, fire retardant paint, which will not ignite or burn at temperatures above 1500 F., is used throughout. There is no wood in the ship except for the chopping blocks in the galley, and the pianos. All the furniture is made of aluminum, with glass fiber as filler for the upholstery, and all the fabrics used for draperies, rugs, and so on, are treated to make them flameproof. The only possible source of fire would be in the passengers' belongings, and since the ship's furnishings and structure will not support combustion, the likelihood of fire is remote.

Fig. 1. Dr. V. K. Zworykin, vice-president and director of research, RCA Laboratories (left center) who was presented the Edison Medal by Donald A. Quarles (right center) president of the AIEE. Extreme left, Professor J. F. Calvert, Northwestern University who gave the history of the medal. Right, E. W. Engstrom, vice-president in charge of research, RCA Laboratories

Fig. 2. The Summer Meeting of the AIEE will be at Atlantic City. Here are shown members of the planning committee. Left to right. L. R. Gaty, Chairman, Miss Lee Schneider of Atlantic City, Max L. Stoughton, publicity chairman Wm. Henn, Lee Nonemaker, J. Baker Harris, E. F. Jones, Julius Strasbourger, and Miss Atlantic City whose cut-out is promoting meeting across the country

Largest Technical Program Draws 4500 to AIEE Meeting

THE 5-DAY winter meeting of the American Institute of Electrical Engineers held in New York, January 19 to 23, was the largest in the history of the Institute, both in the extent of the technical program and the attendance. Over 4500 members — 10 per cent of the membership — attended the 83 technical sessions held during the week.

The meeting was preponderantly technical. Indeed, the only general session was the one on Monday afternoon, the first day of the meeting, at which the Edison medal was presented to Dr. Vladimir K. Zworykin, Vice-President of the Radio Corporation of America, for "his outstanding contribution to the concept and design of electronic components and systems". This session also included an address by Chancellor Henry Heald of New York University, and a report of the Institute activities by Donald A. Quarles, President of the Institute and of the Sandia Corporation.

The subjects discussed at this meeting covered the whole gamut of electrical engineering, ranging all the way from a philosophical discussion of "What is Voltage?" to the practical and economic aspects of electric space heating and induction motor control. Among the papers presented at the Nucleonics session on Tuesday morning, the paper by John Menke on the nuclear power reactor dramatically emphasized the difference between atomic energy and coal. Mr. Menke began his talk by holding up a small black rod about six inches long and ¾ inch in diameter. This rod, he told the audience, was made of uranium metal. It weighed 3 pounds. To prove that it was uranium, he held it close to a small Geiger counter which indicated it to be intensely radio active. There was no doubt of its radioactivity.

The really startling thing about this little rod, however, was not so much in the radioactivity which it exhibited but in the way Mr. Menke compared it with coal. This rod, said Mr. Menke, could produce as much heat as there was in 100 cars of 50 tons each of coal by destroying only 1/1000 part of its mass.

The tremendous amount of heat in uranium, when it undergoes nuclear fission, brought up the question as to the amount of uranium in the world. Mr. Menke showed a world map,

(*Continued on page 120*)

Fig. 3. Apparatus used by Dr. F. G. Guest of the U.S. Bureau of Mines to demonstrate the hazards due to static electricity in hospital operating rooms. In this picture, Dr. Guest (left) is demonstrating to Hendley Blackman of Westinghouse, how an electroconductive tube and face mask of an anesthesia machine will leak off electrostatic charges and prevent explosion of the anesthetic gas during surgery

Any way you figure it, corrosion of steam and condensate lines is a serious problem . . . and a costly one! Replacement of corroded lines, interrupted production, increased labor and maintenance send costs spiraling far beyond the limits of economical plant operation. But something can be done about it *right now*, with complete assurance of satisfactory results.

Take the case, for example, of a large plastics molding plant which operated the cycle on its molding machines alternately with steam and oxygen-saturated cooling water. Under these conditions, severe corrosion resulted. Check valves on the steam supply lines to the machines had an average life of only one week—*sometimes even less!* Costs were skyrocketing.

Here's what Betz did about it. By applying its patented filming amine treatment, piping and valve losses stopped *immediately!* After three years' treatment with this advanced technique, satisfactory corrosion control continues. What's more, plant records show savings in labor and maintenance have averaged 30 times the cost of the treatment applied.

This is just one example of how Betz Engineers help keep plants *like yours* at peak operating efficiency. Why not get in touch with Betz today as the first step toward solving your particular water problems. There's no obligation, of course. W. H. & L. D. BETZ, Gillingham & Worth Streets, Philadelphia 24, Pa. In Canada: Betz Laboratories Limited, Montreal 1.

For the full facts and figures on how BETZ is solving return line corrosion problems in plants like yours, write today for Technical Paper No. 124.

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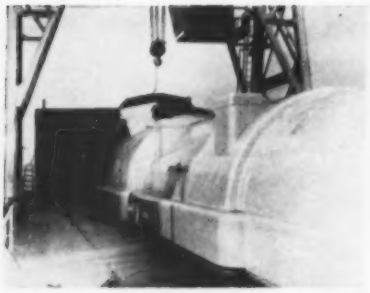


Fig. 2. Outdoor 66,000-kw turbine generator; walk-in housings over governor and exciter; central control room at far end; 30 ton gantry crane

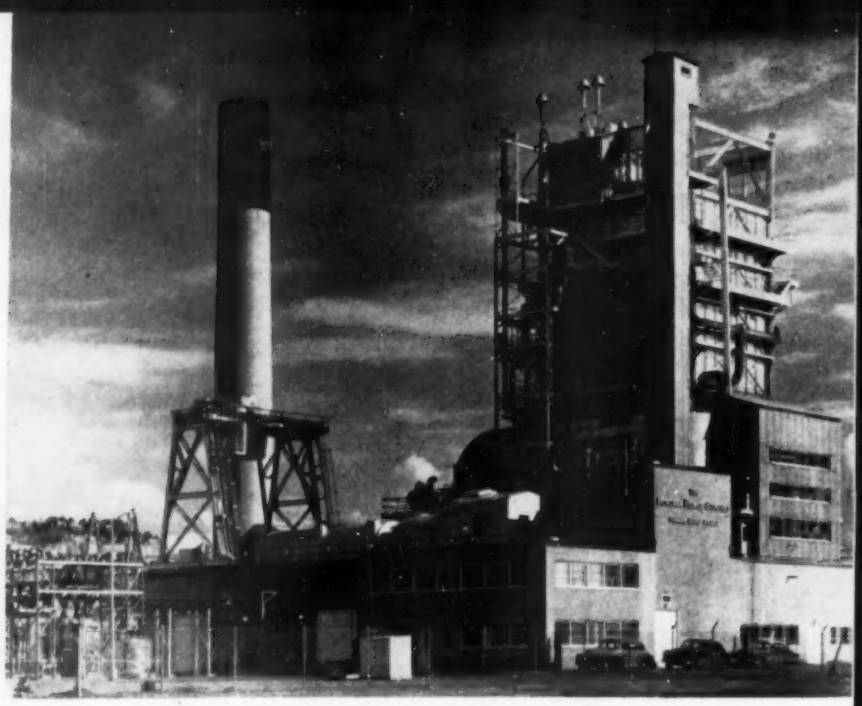


Fig. 1. Close-up view of the Frank W. Bird steam-electric station showing the outdoor turbine and boiler

Fig. 3. Circulating water intake, showing severe winter conditions. Circulating water is supplied by a single vertical pump installed on the river bank

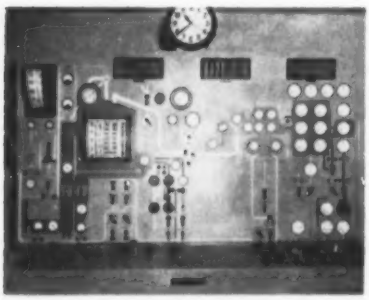


Fig. 4. This graphic panel, using miniature instruments, provides complete mechanical and electrical control from central control room

Montana winter tests Frank W. Bird

Outdoor Station Design

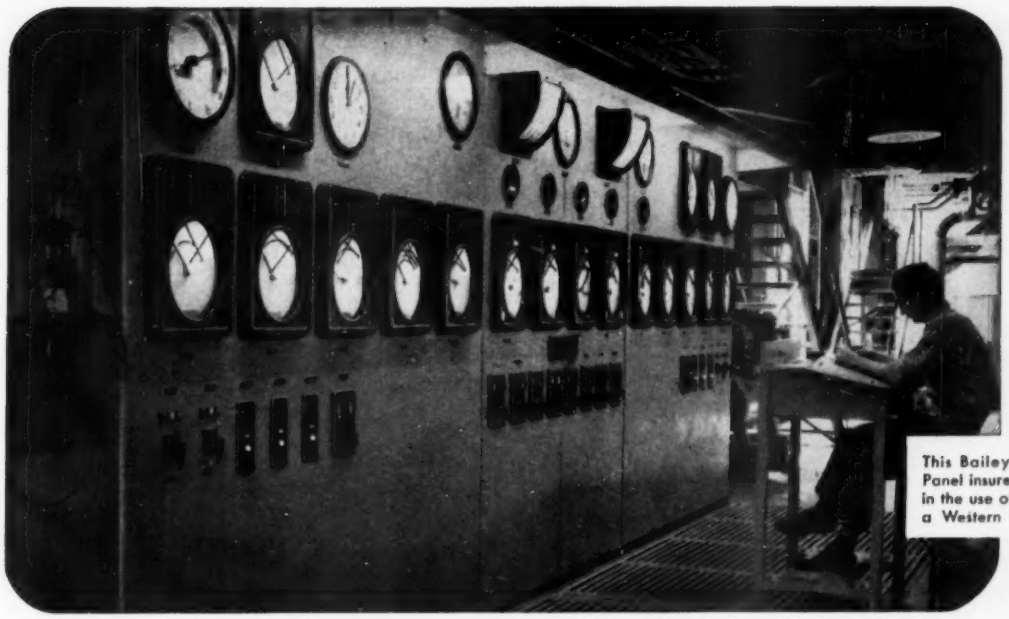
FRANK W. BIRD steam-electric station of Montana Power Co. at Billings, Montana, a 66,000-kw outdoor plant, was successfully operated through its first winter, 1951–52, with temperatures as low as −30 F. See Semi-outdoor Plant for −40 F Weather; The Frank Bird Steam-Electric Station, by D. G. Iliff, POWER ENGINEERING, April 1951.

This plant was designed for a long-range load factor of less than 30 per cent, backing up the hydro systems. However, in low water years it will be called on for full capacity 7 to 9 months of the year. To meet these conditions, the plant was designed for low fixed, fuel and operating costs. Its completed cost, including land, switchgear and transformer, on the basis of 66,000 kw, is approximately $87 per kw.

The station consists of a single 66,000-kw preferred standard turbine generator, supplied with steam at 920 psig, 905 F by a single oil- and natural-gas-fired, 675,000-lb-per-hr steam generating unit, designed for future coal firing.

On the outdoor boiler, enclosures or antifreeze protection against ambient temperatures as low as −40 F are provided for all piping. Firing aisle and steam drum ends have walk-in shelters. Headers, valves and rear boiler connections are protected.

Fig. 5. General view of Frank W. Bird station on Yellowstone River at Billings, Montana. The plant is operated by four men per eight-hour shift, with eight additional men on the day shift, a total of 24 men on a 42-hour work week basis. Fuel oil comes in 6-in. overhead pipeline from nearby refinery. Frank W. Bird station was designed by Ebasco Services, Inc. under the supervision of H. H. Cochrane, consulting engineer, Montana Power Co., and A. B. Martin, company's chief engineer at Butte, Mont.



This Bailey Boiler Control Panel insures high efficiency in the use of Fuel-Dollars at a Western Chemical Plant.

What's Your Fuel-dollar Efficiency?

A dollar's worth of fuel has the *same potential* energy, no matter who's boiler it fires. But how much of the energy actually gets converted to a usable form depends on how you operate your boiler.

That's where Bailey Controls can help. And, here's why, we believe, you'll get better fuel-dollar efficiency with Bailey:

1. **Complete Range of Equipment—fully co-ordinated.** You need never worry that a Bailey Engineer's recommendation is slanted in favor of a particular type of equipment, just because he has a limited line to sell—or that Bailey will pass the buck for efficient control; we offer *complete* boiler control systems.

2. **Engineering Service—backed by experience.** No other manufacturer of instruments and controls can offer as broad an experience, based on successful installations involving all types of combustion, flow measurement and automatic control.

3. **Direct Sales-Service—conveniently located near you.** Bailey Meter Company's Sales-Service Engineers are located in more industrial centers than those of any other manufacturer of boiler control systems; you get prompt, experienced service with a minimum of travel time and expense.

•

For better fuel-dollar efficiency—for more power per fuel-dollar, less outage and safer working conditions, you owe it to yourself to investigate Bailey Controls. Ask a Bailey Engineer to arrange a visit to a nearby Bailey installation. We're proud to stand on our record: "More power to you!"

A-109-1

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Controls for Steam Plants
COMBUSTION · FEED WATER
TEMPERATURE · PRESSURE
LIQUID LEVEL · FEED PUMPS

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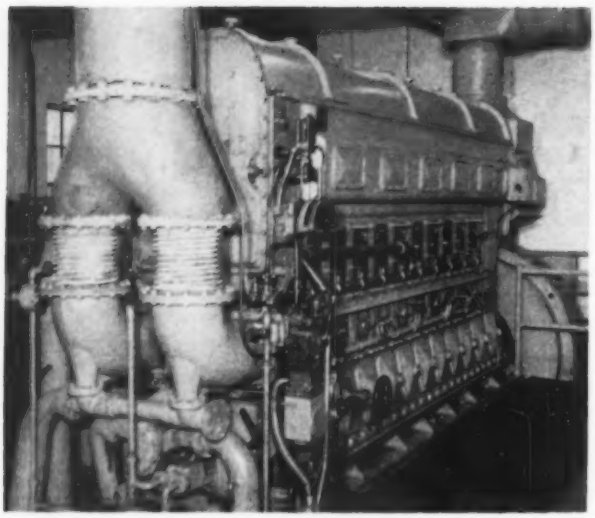


This 1600-hp opposed-piston engine at Wells, Minn., is one of the first of its type to run as a dual-fuel

An O-P Goes Dual-Fuel

AN OPPOSED-PISTON engine operating as a dual-fuel unit has completed its first full year of service in the Wells, Minn., municipal power plant. The 10-cylinder engine, rated at 1600 hp at 720 rpm, was installed as an oil-burning diesel in December, 1950; and operated on diesel fuel for the first 8 months of 1951. Then, switched to natural gas with diesel oil as pilot fuel, the unit has run more than 6000 hr as a dual-fuel engine.

As an oil-burning engine, the O-P established itself as the most economical of three large diesels in the plant. Operating 3664 hr, the engine produced 2,186,700 kwh while consuming 167,150 gal of fuel oil — better than 13 kwh per gal with average load less than 600 kw. However, this performance is hardly as noteworthy as the engine's success utilizing natural gas.

In the first 11 months of dual-fuel service, the engine ran 6308 hr — more than 78 per cent of the time. It produced 4,861,900 kwh of the 5,892,400-kwh plant total. During the year, the O-P ran about 275 hr on oil, generating 210,400 kwh on 16,180 gal of fuel. As a dual-fuel, it produced 4,651,500 kwh while consuming 62,827,000 cu ft of natural gas and 38,790 gal of pilot oil.

Some Cost Figures

Effect on operating cost of these successive changes in fuel is a matter of prime concern. In 1950, the diesel used a crude oil which cost the city 10 cents a gal, and with average consumption at 12.04 kwh per gal, fuel cost was 8.30 mills per kwh. In the 8 months of 1951 average cost per kwh was 7.64 mills. For the dual-fuel service during the 11 months of 1951 and 1952, using pilot oil at 11.58 cents a gal and natural gas at 26 cents per mcf, average fuel cost per kwh dropped to 4.47 mills. Compared with costs in 1950, installation of the O-P and its subsequent operation on natural gas has meant a fuel saving of more than $19,000.

The statement of revenue and operating expenses for 1951 showed how this municipal power system maintains its sound financial condition. Energy sales brought an income of $151,288.47. Plant operation costs, distribution, accounting and collections and administration gave a total operating expense of $78,749.02. This left an operating profit of $72,539.45. Of this sum, the department paid $1800 in bond interest (which was just about balanced by other income), wrote off the water department's electric bill, and paid $10,000 to the city in lieu of taxes. This left a net of $60,311.39.

It should be noted that these profits were achieved with only four months of dual-fuel operation. The 1952 figures will be the first to reflect a full year of dual-fuel economy.

Operating Details

When installed, the engine was placed in an L of the plant — separated from the other engines, but integrated with them. All engines are on a common jacket-water header. Two motor-driven centrifugal pumps circulate water through the engines and through coils in a 3500-hp dual forced-draft cooling tower. Another pair of pumps puts raw water through the tower spray nozzles. To control water temperature, there are automatic thermostatic valves to bypass raw water around the nozzles, and automatic controls for tower shutters. Fans are manually controlled.

A high detergent lubricating oil is used in the pressure system of the O-P engine and some of this oil is bypassed through a 10-element cellulose filter. The engine runs cleaner when using gas and the lube remains in excellent condition after thousands of engine hours. Lube system includes a shell-and-tube oil cooler with automatic thermostatic bypass valve, and a motor-driven auxiliary lube pump.

A gas oil of 32 to 36 gravity is used for pilot fuel in the O-P and a good quality Texas crude for the other engines. It is the intention to switch the O-P to the cheaper crude which will effect further economies in the engine's fuel cost per kwh. The plant has three 20,000-gal fuel storage tanks from which oil is pumped through filters and meters to underground day tanks just outside the building. Built-in engine supply pumps pick up fuel from the day tanks and send it through additional filters to injection pumps. Natural gas for the O-P comes to the plant through a 4-in. line at 43 lb, passes through a meter and regulators to reach the engine at 19 lb. Governor controls are arranged so that the engine can operate on gas plus pilot oil, or wholly on oil. The unit switches automatically if pilot oil or lube pressures fail.

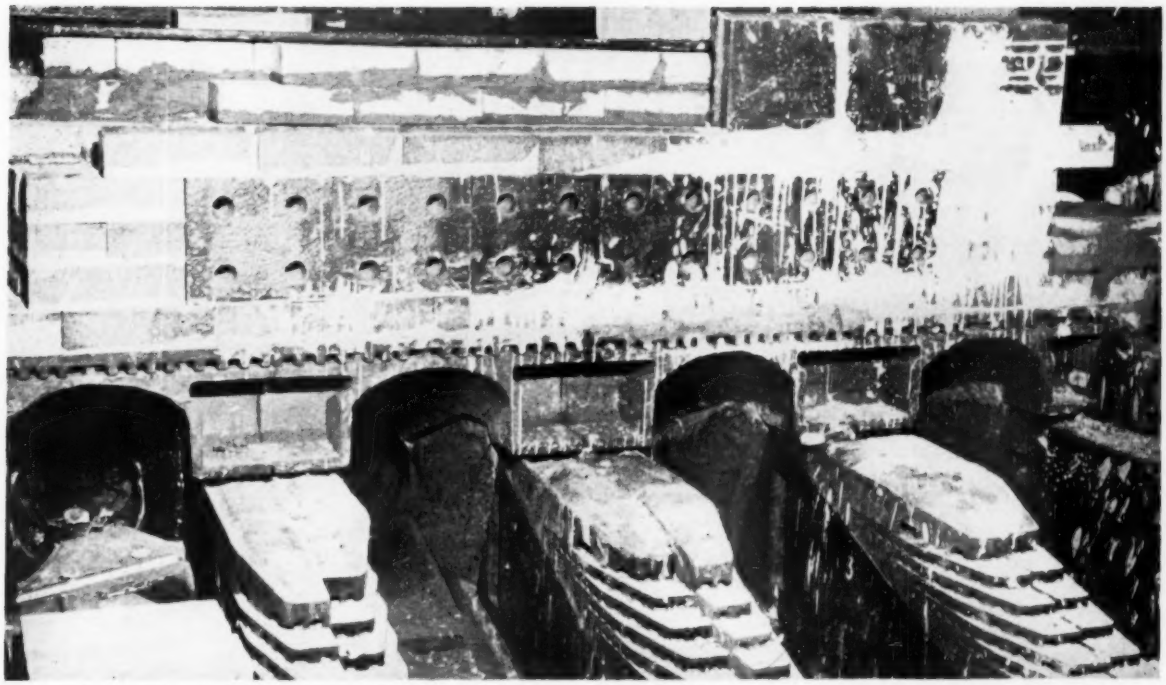
PRINCIPAL EQUIPMENT FOR O-P ENGINE

Engine	Fairbanks, Morse & Co.
Alternator	Fairbanks, Morse & Co.
Governor	Woodward Governor Co.
Natural gas	Peoples Natural Gas Co.
Gas pressure regulator	Fisher Governor Co.
Pilot oil	Diesel Service Co.
Fuel filters	Wm. W. Nugent & Sons
Fuel meters	Buffalo Meter Co.
Fuel level meter	Liquidometer Corp.
Lube oil	Standard Oil of Ind.
Lube filters	Fairbanks, Morse & Co.
Auxiliary lube pump	Geo. D. Roper Corp.
Lube oil cooler	Kewanee-Ross Corp.
Temperature control	Fulton Sylphon Co.
Lube oil purifier	Renuoil
Cooling tower	Diesel Service Co.
Water treatment	Flox
Air filter	American Air Filter Co.
Snubber	Burgess-Manning Co.
Switchboard	General Electric Co.
Gage panel	Fairbanks, Morse & Co.
Pyrometer	Ill. Testing Lab., Inc.
Gages	Marshalltown
Crane	Industrial Equipment Co.

First Supercharged Steam Turbine Generator Record

GEORGE SCHILSTRA, generating station manager, Wisconsin Power and Light Co. reports availability of 100 per cent was maintained during 1952, the first full calendar year of operation, by the world's first supercharged steam turbine generator.

The new generator — a 60,000-kw Allis-Chalmers unit with supercharged hydrogen-cooled rotor — is installed at the utility's Edgewater station in Sheboygan, Wis. Out of a total of 8784 hours in 1952, it was in service 8557 to establish a 97.41 per cent service factor.



AIR-COOLED CRYSTOLON* REFRACTORY BLOCKS add extra life to the front wall of this boiler-furnace, fueled by multiple retort stokers. Mating tongues and grooves of these blocks simplify construction. The highly refractory, dense, abrasion-resistant nature of their CRYSTOLON refractory composition promises years of service with minimum down-time for maintenance.

How to get EXTRA power from SPECIAL refractories

Every time you shut down a boiler to repair spalled, eroded or cracked walls, you lose power you can never get back.

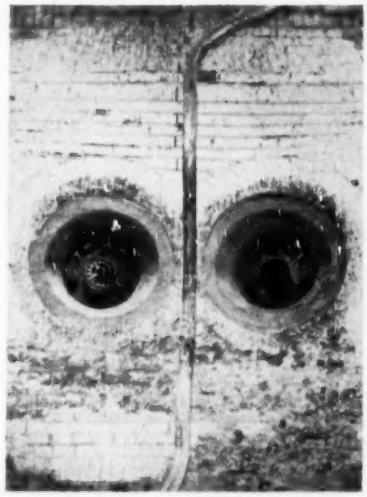
That's why it pays to keep maintenance interruptions at an absolute minimum with refractory blocks and bricks engineered to fit your exact requirements.

That's where your nearby Norton representative enters your power picture. To help you get the most power out of your boilers, he is ready to call on the research resources of Norton . . . pioneers for 40 years in the development of special refractories for complicated high-temperature applications.

Whether your power requirements call for air-cooled blocks or solid brick, you can be sure that the Norton CRYSTOLON refractories you get will give you the greatest resistance to the four common causes of boiler wall failure.

1. ***Temperatures up to 2900° F*** have little or no effect on Norton CRYSTOLON blocks and bricks.
2. ***Slag can't penetrate*** their dense structure.
3. ***Clinker adhesion is so slight*** that clinkers can be easily removed without damage to surfaces.
4. ***Abrasion of moving fire beds*** of stoker-fired furnaces has little or no effect on CRYSTOLON silicon carbide . . . itself a tough abrasive.

For more complete information about Norton CRYSTOLON refractories and the Norton Service that engineers them to your exact requirements, consult your nearby Norton representative, or write direct to Norton Company, 612 New Bond Street, Worcester 6, Mass. Canadian Representative: A. P. Green Fire Brick Co., Ltd., Toronto, Ontario.



THESE BURNER RING PORTS for oil or powdered fuel firing of a power boiler are made of a Norton CRYSTOLON refractory cement, especially designed to resist high temperatures and abrasive action.

NORTON

Special REFRACTORIES

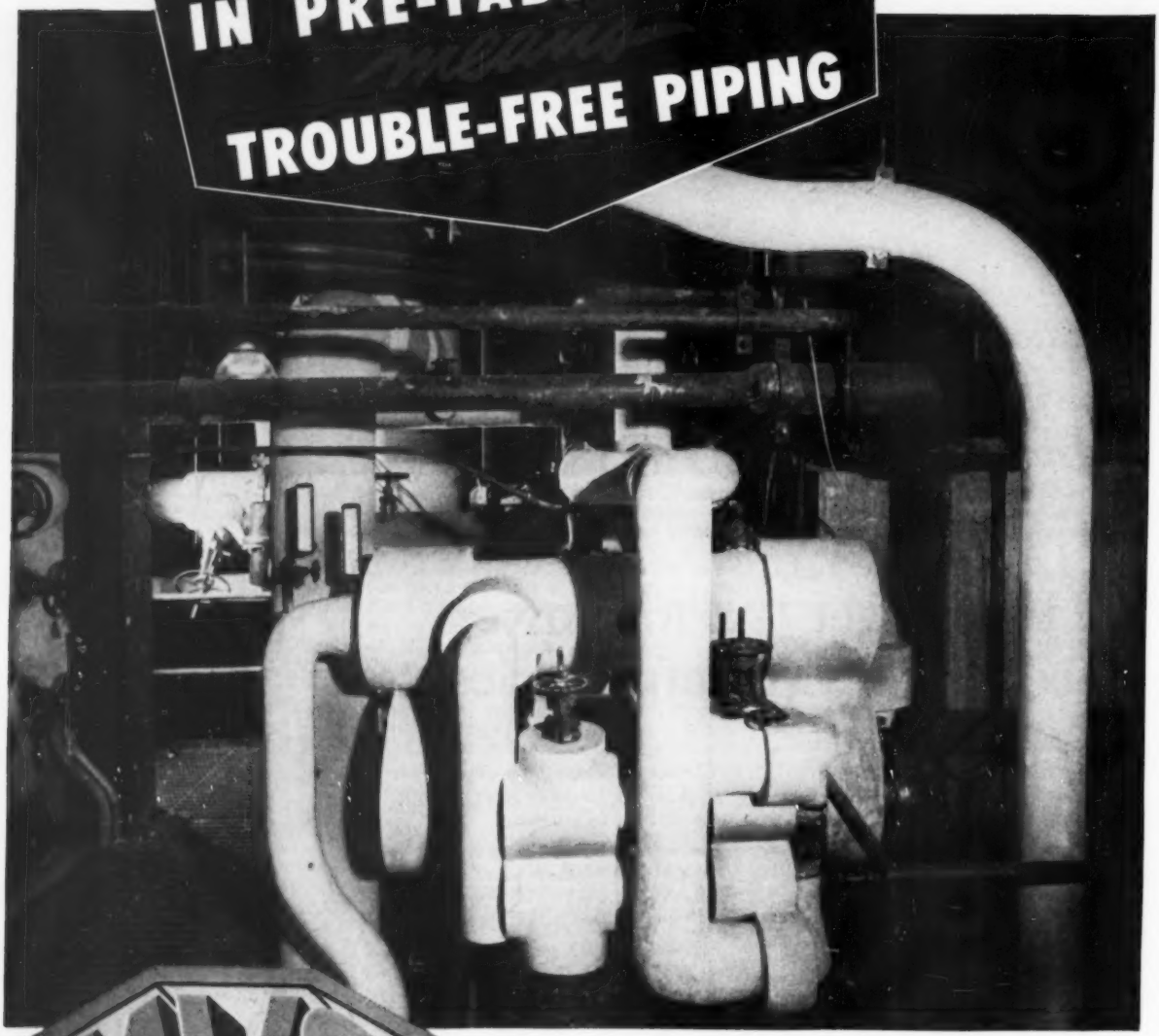
Making better products to make other products better

NORTON COMPANY, WORCESTER 6, MASSACHUSETTS

*Trade-Mark Reg. U. S. Pat. Off. and Foreign Countries

For more data circle 534 on Post Card

NAVCO ACCURACY IN PRE-FABRICATION TROUBLE-FREE PIPING



NAVCO

Prefabrication accuracy is an essential "MUST" to assure a proper fit and economical operation. Navco's 40 years' experience in fabricating assemblies in all sizes and for all operating conditions is your assurance of such accuracy.

Consult Navco for your next piping job

NAVCO PIPING

NATIONAL VALVE & MANUFACTURING COMPANY • PITTSBURGH, PA.

NEW YORK • CHICAGO • CLEVELAND • BOSTON • ATLANTA • TULSA • BUFFALO • CINCINNATI

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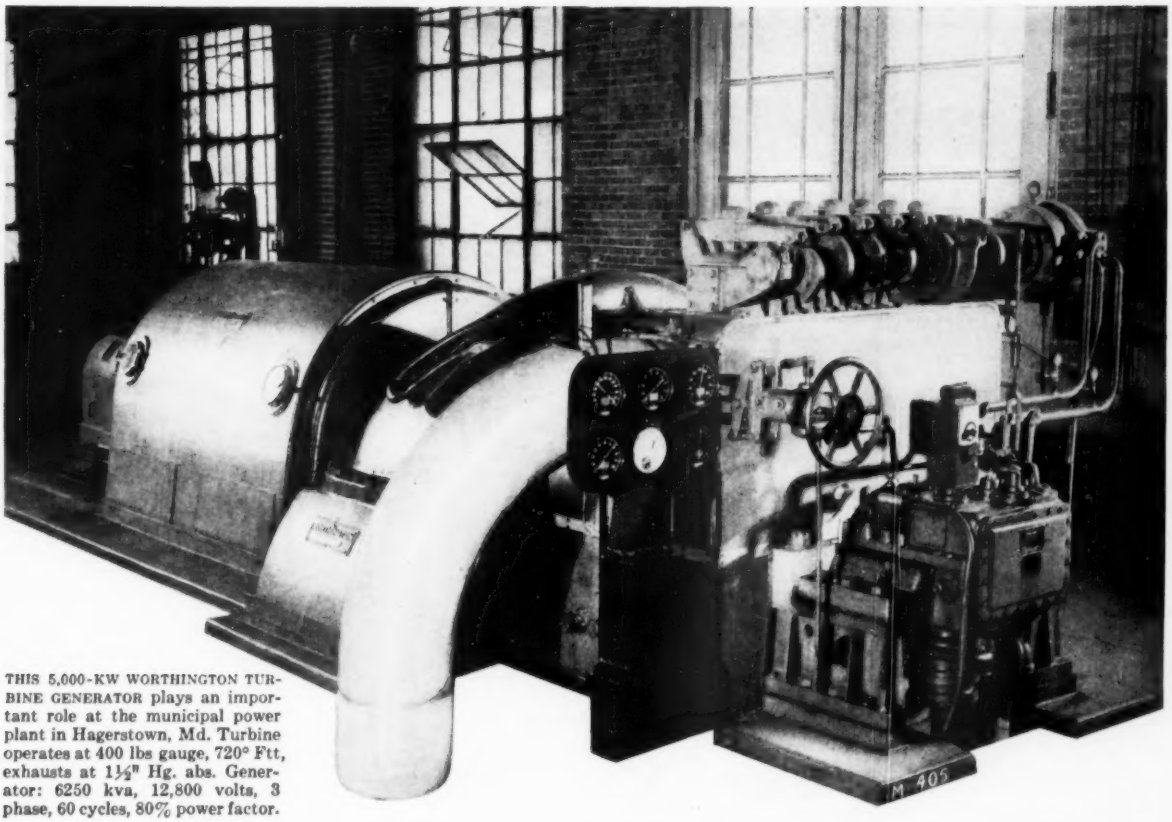

THIS 5,000-KW WORTHINGTON TURBINE GENERATOR plays an important role at the municipal power plant in Hagerstown, Md. Turbine operates at 400 lbs gauge, 720° Ftt, exhausts at 1½" Hg. abs. Generator: 6250 kva, 12,800 volts, 3 phase, 60 cycles, 80% power factor.

WORTHINGTON turbine generator at City of Hagerstown, Md. completes second year of continuous operation

A little over two years ago Hagerstown, Maryland, took one of the biggest steps in its $1,500,000 post-war power-plant expansion program. They installed and began operating a 5,000-kw Worthington turbine generator unit.

Fulfilling the reputation for reliable performance held by all members of Worthington's team in steam, this power supply has run continuously since installation.

Hagerstown is just another of the many Worthington users that are reaping the rewards of the experience and specialized engineering that go into the manufacture of these long-life, ever-dependable turbine generators.

Keynote of Worthington's service reliability is the advantage you get because Worthington turbine generators are designed, assembled and tested for combined operation—as a complete unit—*before* shipment. Built in sizes up to 10,000 kw, the performance records of these machines are added proof that *there's more worth in Worthington*. For detailed information, consult your nearest Worthington representative or write to Worthington Corporation, Steam Turbine Division, Wellsville, New York. T.1.11

SINGLE-STAGE TURBINES | MULTI-STAGE TURBINES | TURBINE-GENERATOR SETS | FEED WATER HEATERS | BOILER FEED PUMPS | SURFACE CONDENSERS

A GREAT TEAM IN STEAM

WORTHINGTON

Steam Turbine Generators

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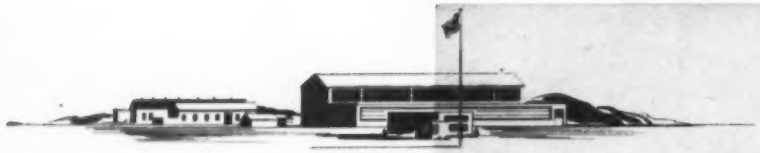


From B&W Research and Development . . .

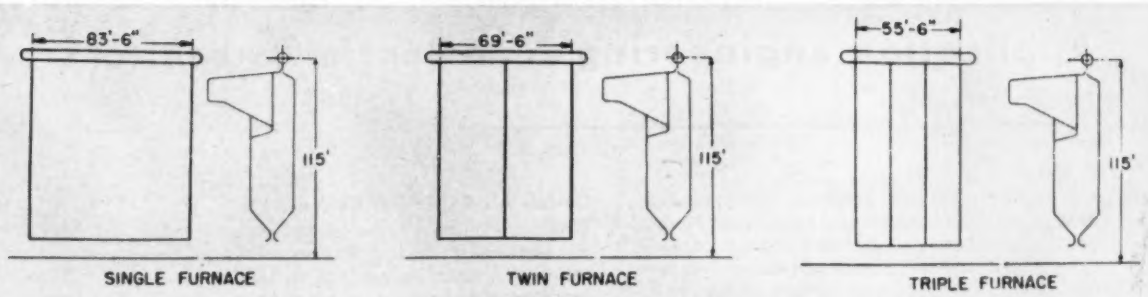
a practical solution to cost problems...

B&W DIVIDED

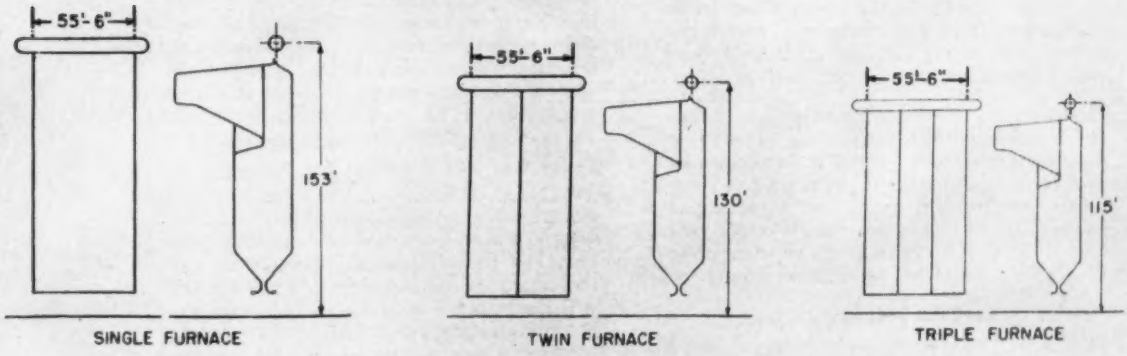
A practical, long-proved solution to rising construction costs may be found in the B&W Divided-Furnace Boiler. Whether it is a problem of conserving height, width, or both—especially for units with large heat input—B&W's Divided-Furnace design offers remarkable economies. The sketches on the opposite page show typical savings in space for twin-furnace and triple-furnace construction as compared with single-furnace construction.

A furnace division wall receives heat from both sides and therefore must be assured an adequate supply of water. With the B&W Cyclone-Steam Separator, circulation in division walls of B&W boilers has always been more than ample—as proved by long-term central station operation at boiler design pressures as high as 2650 psi. Many years of experience stand behind B&W's Divided-Furnace construction with all types of large units—Radiant, Stirling, and Open-Pass. Over 75 B&W Divided-Furnace Boilers are in operation—many for over 10 years—and more than 80 units are under construction, for the following electric utilities:

Alabama Power Company • Appalachian Electric Power Company • Arkansas Power & Light Company • Cincinnati Gas & Electric Company • City of Los Angeles • Cleveland Electric Illuminating Company • Commonwealth Edison Company • Consolidated Edison Company of N. Y. Inc. • Consolidated Gas, Electric Light & Power Company of Baltimore • Dallas Power & Light Company • Detroit Edison Company • Duquesne Light Company • Electricite France • Georgia Power Company • Houston Lighting & Power Company • Indiana & Michigan Electric Company • Jersey Central Power & Light Company • Kentucky Utilities Company • Long Island Lighting Company • Middle South Utilities, Inc. • Monongahela Power Company • Niagara-Mohawk Power Corp. • Northern Indiana Public Service Company • Ohio Edison Company • Ohio Power Company • Pacific Gas & Electric Company • Pennsylvania Electric Company • Philadelphia Electric Company • Public Service Company of Colorado • Public Service Company of Northern Illinois • Public Service Company of Indiana Inc. • Public Service Company of Oklahoma • Public Service Electric & Gas Company • Southern California Edison Company • Tennessee Valley Authority • Texas Electric Service Company • Texas Power & Light Company • Toledo Edison Corp. • Union Electric Company • West Penn Power Company • Wisconsin Power & Light Company



EFFECT OF DIVISION WALLS ON BOILER WIDTH—KEEPING HEIGHT CONSTANT



EFFECT OF DIVISION WALLS ON BOILER HEIGHT—KEEPING WIDTH CONSTANT

FURNACE

Division wall furnace construction is used in combination with other significant achievements of B&W Research and Development, including the Cyclone Furnace, Pressure-Firing, Gas Recirculation, and improved alloys for high steam temperatures. Widely accepted throughout the power industry, these modern B&W advances are making major contributions to more economical and reliable steam generation.

B&W's continuing program of progressive research combined with its broad experience in designing and building boilers with the highest capacities in existing pressure-temperature ranges, assure you of the most efficient and economical solutions to your specific steam generation problems.

ADVANTAGES OF DIVIDED FURNACE CONSTRUCTION

- Provides greater cooling area without increasing furnace volume
- Reduces steel and other material costs by keeping boiler and building volume to a minimum
- Lowers furnace construction costs
- Cuts operating costs by reducing slagging in furnace and in convection surface

Triple furnace boilers for 1 boiler—1 turbine units of over 200,000 KW capacity are now being constructed

BABCOCK & WILCOX

G-5691

For more data circle 537 on Post Card

Application engineering . . . *essential to control*

No matter what the product, every plant uses methods, materials and equipment that present problems peculiar to its own production. Specifications . . . size of plant . . . rate of output . . . all impose further unique restrictions.

What, then, about process control instrumentation? To do its job right, it has to be designed with all those factors . . . and many others . . . in mind. And here is where Honeywell Application Engineering steps in.

First comes a thorough investigation of control requirements. A Honeywell engineering representative, well versed in instrumentation techniques sits down with process engineers, production men, and instrument technicians . . . discusses details of the specific process. Then he puts the problem up to Honeywell's staff of application engineers.

Specialists for Each Industry

In this group are men who are expert in each specific industry. One group, for example, specializes in instrumentation for the metalworking industry . . . another for chemical . . . another for petroleum . . . until the whole gamut of modern manufacturing is represented. Each man has been trained, by education and first-hand experience, in the techniques of processing and process control in the area of his interest. Each is a living part of the industry he serves. And he knows why and where every process "is different."

Covers All Aspects of Control

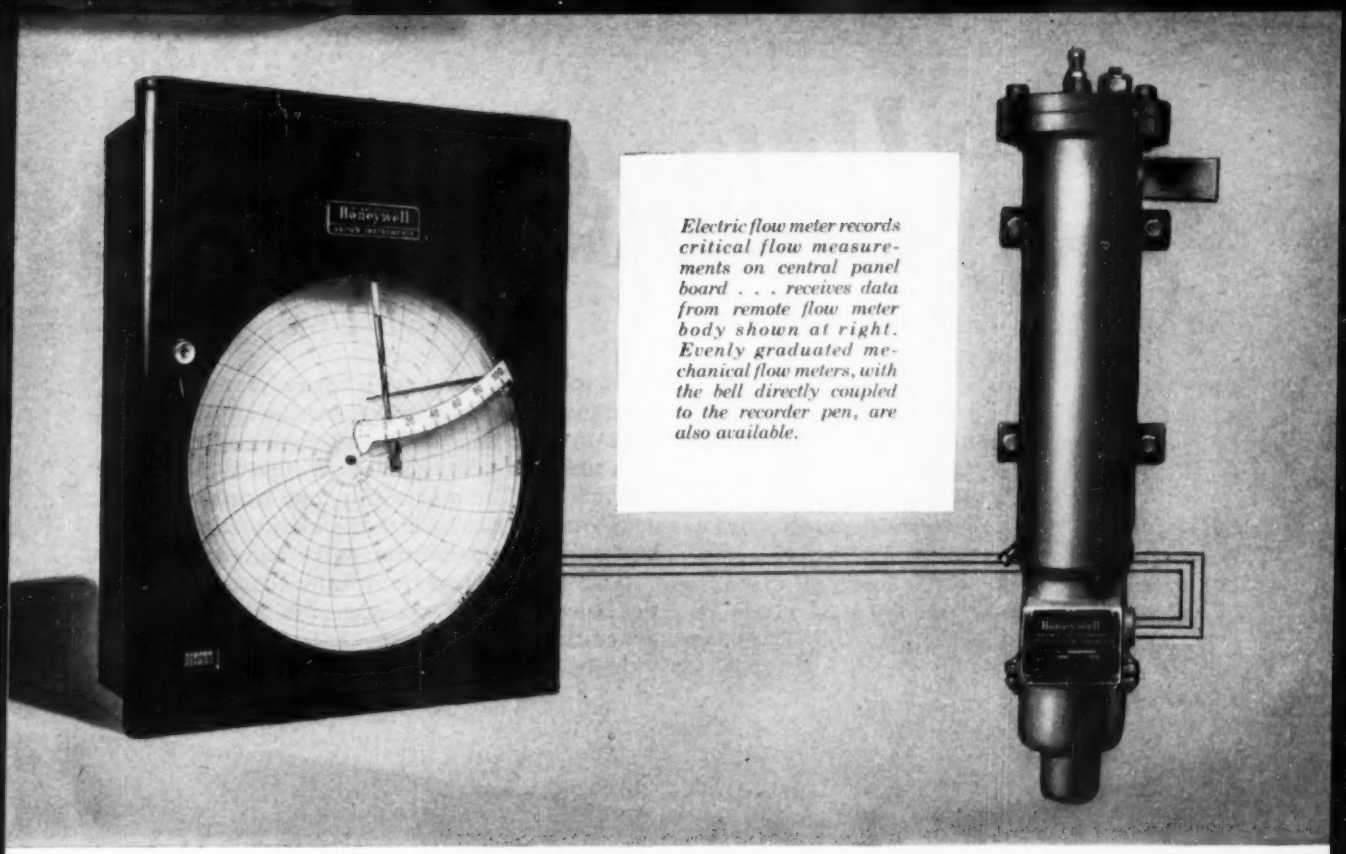
Honeywell application engineering covers the entire control installation. It works out details of what instrument to use for each measurement or control function . . . what type of primary element . . . what control system . . . what size and style of valve. It provides all essential signals, safety interlocks, and accessories. It combines all these elements into a complete unit, arranged for peak production efficiency . . . greatest convenience of the operator, and for maximum ease of service . . . custom-fitted to the individual needs of the process to be controlled.

Saves Time . . . Produces Top Performance

This Honeywell service gives specialized consultation on complex control problems that would otherwise require the attention of experts in the individual plant. But most important, it assures a control system that will produce the superior performance that Honeywell instruments are capable of giving . . . and which will help to obtain the most production and best quality from the process which it serves.

Choose the *for easy*

SOUND PLANNING, *based on specialized engineering experience, forms the basis of Honeywell Application Engineering. Here a round-table discussion between customer and Honeywell technicians irons out the initial control requirements for a process.*



Electric flow meter records critical flow measurements on central panel board . . . receives data from remote flow meter body shown at right. Evenly graduated mechanical flow meters, with the bell directly coupled to the recorder pen, are also available.

Brown Electric Flow Meter

reading . . . accurate integration

ACCURATE information on steam and water flow at vital points in the plant is always at your fingertips when you use the Brown Electric flow meter. Electric transmission brings data accurately, instantaneously from the point of measurement. This instrument's evenly graduated scale and chart provide easy readability and consistent accuracy at all flow values . . . invaluable in cost accounting and heat balance calculations.

The built-in electronic integrator sets a new standard of precision and simplicity. It scans at a rate of twelve times per minute—detects every significant flow change . . . measures on a 6-digit counter. The entire assembly has only three major parts, all accessible for quick checking and calibration.

The meter body features corrosion-resistant, light weight design . . . has a characterized bell . . . designed to provide the utmost accuracy.

Our local engineering representative will be glad to discuss applications to your plant's flow-measuring problems. Call him today . . . he is as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4587 Wayne Ave., Philadelphia 44, Pa.

● **REFERENCE DATA:** Write for Catalog 2300, "Evenly Graduated Flow Meters"... and Bulletin 90-2, "Supervisory Instruments for Power Generation."

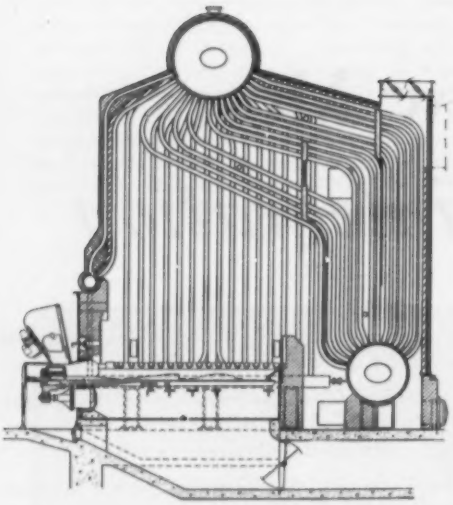
MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS
First in Controls

For more data circle 538 on Post Card

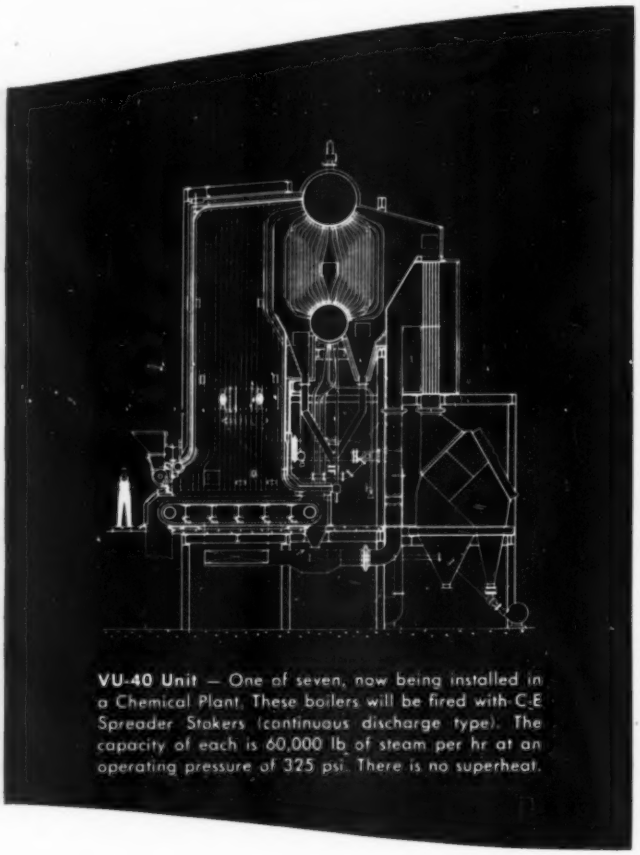
VU Utility Standards

Electric utility companies maintain the highest equipment standards in the power generation field. Kilowatts are their business — their product . . . to be turned out reliably, efficiently and at the lowest possible cost. To assure this they demand — and get — the most reliable — the most efficient — the best built boilers that the market affords.

To meet their highly critical standards the utilities have long been accustomed to purchase steam generating units that were, in large measure, individually designed to meet their particular needs.



VU-10 Boiler — This unit is installed in a hosiery mill. It is fired by a Type E Underfeed Stoker. Capacity — 12,500 lb steam per hr; operating pressure — 100 psi; no superheat. VU-10 Boilers are available in sizes from 10,000 to 60,000 lb of steam per hr.



VU-40 Unit — One of seven, now being installed in a Chemical Plant. These boilers will be fired with C-E Spreader Stokers (continuous discharge type). The capacity of each is 60,000 lb of steam per hr at an operating pressure of 325 psi. There is no superheat.

COMBUSTION ENGINEERING

ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS

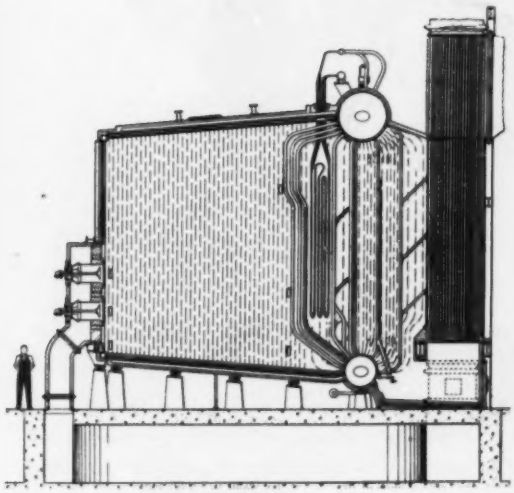
in a Standard Boiler

And C-E Vertical-Unit Boilers, particularly in the larger sizes, are available in "custom-made" designs to suit specific requirements. In fact, VU Units have been a popular choice with utility companies for many years.

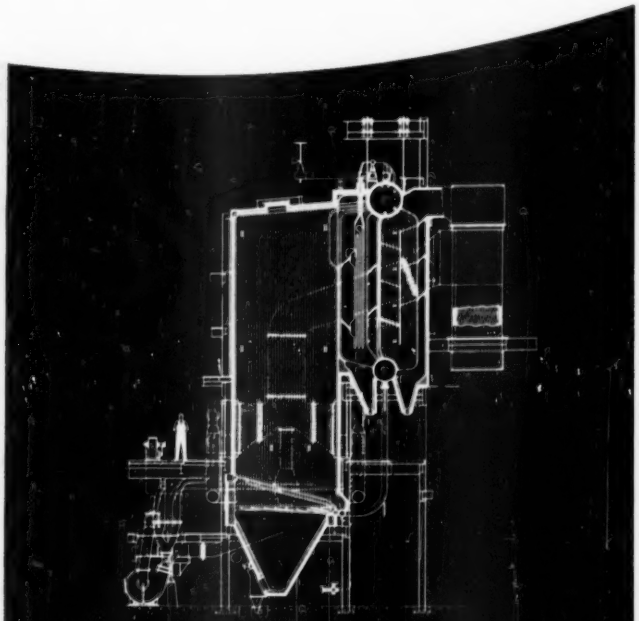
But many other designs that comprise the "VU family" are completely *standardized* . . . standardized without sacrifice of "custom-made" advantages. And when you standardize you reduce engineering costs, reduce manufacturing costs, reduce erection costs — in short, you save money.

Here then is a line of custom-quality boilers with all the benefits of standardization built in capacities from 10,000 lb of steam per hr up, for any pressure and temperature . . . and suitable for any type of fuel burning equipment.

Little wonder that industry — all industry — has found within the VU family a boiler unit exactly suited to its needs. Breweries and hosiery mills, chemical companies and steel plants — all have installed VU Boilers again and again with complete satisfaction. So can you.



VU-50 Boiler — This unit is one of two duplicates installed in a brewery. They are fired with oil or gas. Capacity — 100,000 lb of steam per hr; operating pressure 550 psi; steam temperature 700 F. This particular design is of the bottom-supported type.



VU-50 Boiler — This unit, one of five duplicates, is in service in a large tube mill. It is designed to burn pulverized coal and blast furnace gas. Capacity — 175,000 lb steam per hr; operating pressure — 850 psi; steam temperature 750 F.

—SUPERHEATER, INC.

Combustion Engineering Building, 200 Madison Avenue, New York 16, N. Y.

B-649

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engineering...

While we could not hope to duplicate this Springtime magic which Orioles take for granted, Pipe and Tubular Products is, nevertheless, a firm of engineers. Specialists in our own craft of pipe and tube fabrication, our new, larger plant at Catasauqua, Pa., enables our engineers to produce more goods in less time . . . to serve your needs with maximum speed, and at minimum cost.

Pipe and Tubular Products has a wealth of experience in producing bent tubing elements for boilers, condensers and superheaters of carbon, alloy and stainless steels as well as welded tubing and structural fabrication. Recent additions to our plant now add a complete machining department as well . . . and open up channels for increased service to our customers, both new and old.

Service has always been a specialty with us, and we are particularly adapted to supplying tubes for emergency repair work, usually shipping orders the same day on which they are received.

And, like the Orioles above, we, too, often fly our shipments direct to the site.

PIPE & TUBULAR PRODUCTS
INCORPORATED
Tubing P&TP *Specialists*

OFFICE: 8504 GERMANTOWN AVENUE, PHILADELPHIA 18, PA.
PLANT: CATASAUQUA, PENNSYLVANIA

tubing and piping • warehousing and fabricating • engineering and machining

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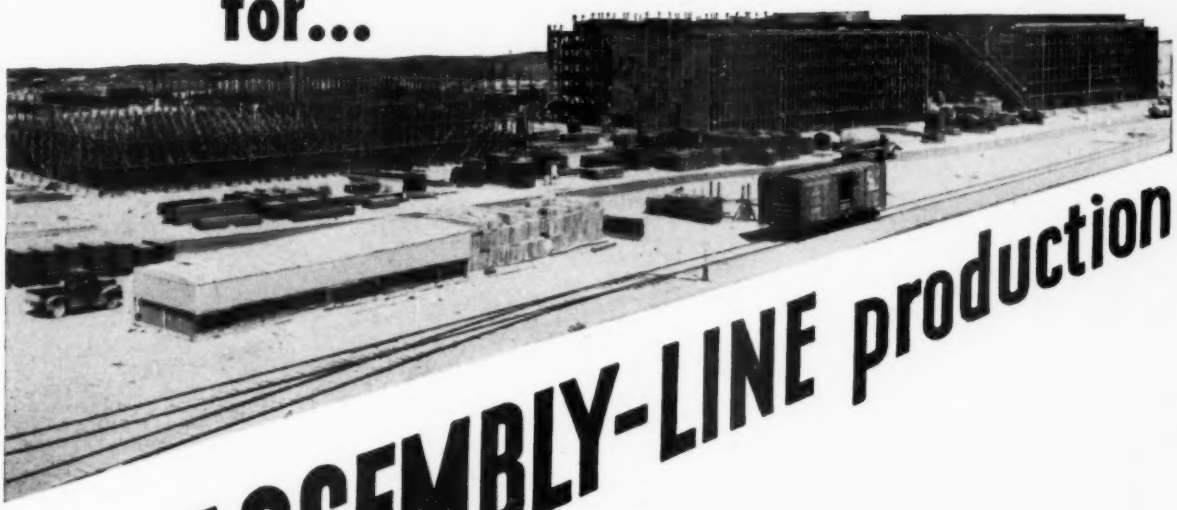
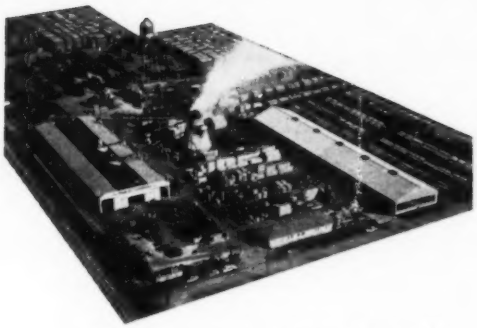
look to MARLEY for...



...ASSEMBLY-LINE production of Giant Cooling Towers



Marley Company plant at Stockton, California—the world's largest prefabricating plant for production of water cooling towers.

At Stockton, California, the Marley Company operates the largest specialized manufacturing plant in the world for prefabricating cooling tower lumber. Here millions of feet of redwood are prefabricated with assembly-line speed, made possible by the most modern equipment and manufacturing techniques.

Hundreds, perhaps thousands, of miles from Stockton, giant Marley cooling towers are erected on the same assembly-line basis. "Prefab" lumber, made to exact engineering specifications, goes into its place in these large towers. Everything fits. There's no time lost.

If you need large water cooling towers, and want to get them into service as quickly as possible, call on the Marley Company. You'll enjoy all the advantages of Marley's "custom-built" engineering, combined with assembly-line methods—advantages that have made Marley the world's leading producer of water cooling towers.

MARLEY

The Marley Company

Kansas City 5, Missouri

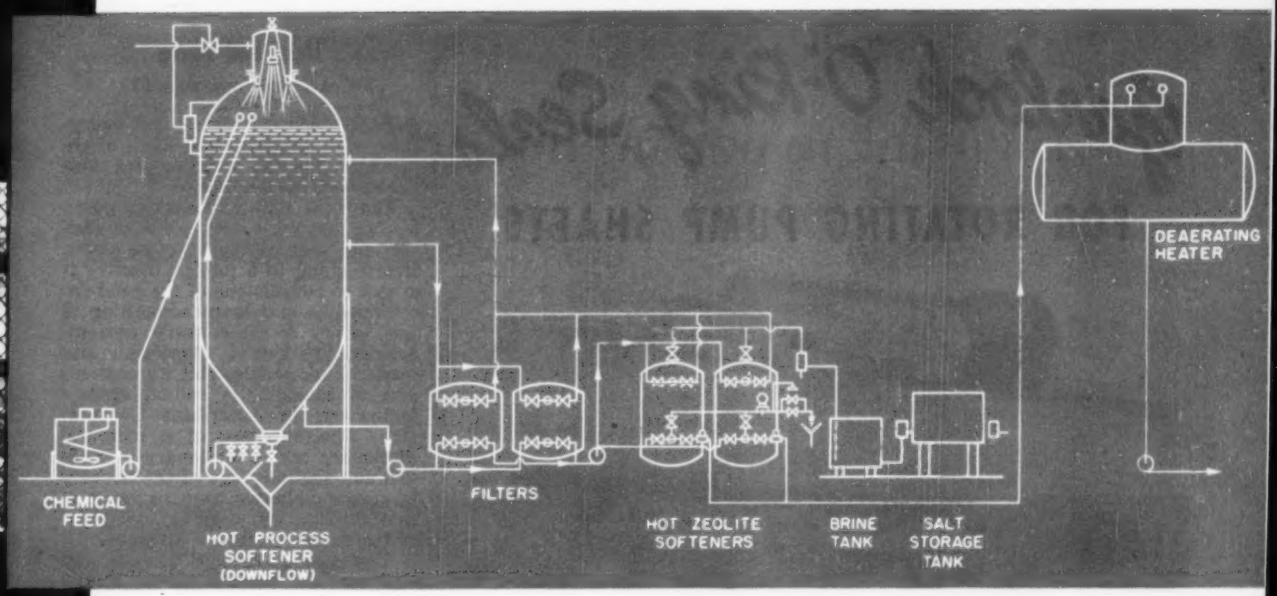
For more data circle 541 on Post Card

"We need an unbiased water conditioning recommendation. Let's get a proposal from

cochrane

Whether your water conditioning problem is simple or complex, call on Cochrane. Our *full range* of water conditioning equipment assures you *unbiased recommendations* and freedom from makeshift methods.

Cochrane recommendations are based on 90 years of specialized experience in water treatment. And those recommendations are without bias or prejudice—because Cochrane designs and builds *every kind and type* of industrial water treating equipment."—From Cochrane you get the plan and the products to give you water of the quantity and quality you want—with greatest economy. Before you decide on any water conditioning system, be sure to consult Cochrane water engineers.



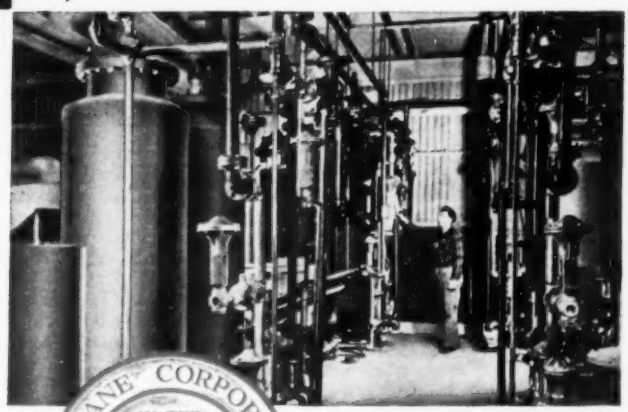
COCHRANE HOT PROCESS ZEOLITE SOFTENER COMBINES EFFICIENCY AND ECONOMY

Combination of a versatile Cochrane Hot Process Softener and a Zeolite second stage provides all the advantages of both systems. It is the most effective and economical means of reducing silica in boiler feedwater preparation. Low total Methyl Orange alkalinities are readily obtained, resulting in lower carbon dioxide in steam generated from this water.

Additional economies and benefits are chemical cost savings obtainable and simplicity of operation. Reason: Inexpensive salt is used for hardness removal instead of more costly soda ash and phosphate. Also, the hardness of the process effluent entering Zeolite units is usually quite low, permitting long Zeolite runs and infrequent regeneration.

LOW COST SOLUTION TO MINERAL SOLIDS PROBLEMS

For economical production of water that is comparable to commercially distilled water in low mineral solids, Cochrane demineralizers are available in multi-bed or mixed bed units of both manual or automatic design for any required capacity. Cochrane demineralizers embody sound design, superior workmanship and conservative ratings to assure maximum operating efficiency and longest life.



Cochrane Automatic Demineralizer producing water of less than 1.0 ppm total dissolved solids in large midwest plant.

Cochrane equipment covers the full range of water conditioning:

HOT PROCESS SOFTENERS
HOT AND COLD ZEOLITE SOFTENERS
DEAERATORS & OPEN HEATERS
DEMINERALIZERS DEALKALIZERS
DEGASIFIERS REACTORS & CLARIFIERS
CONTINUOUS BLOWOFF SYSTEMS
STEAM SPECIALTIES CONDENSATE RETURN SYSTEMS

To give you prompt consultation and service, Cochrane Water Engineers are strategically located in 29 cities throughout the United States. Write for the address of our office nearest you.

COCHRANE CORPORATION
WATER ENGINEERS FOR
90
YEARS
1863 - 1953

cochrane

corp. 3123 N. 17TH STREET • PHILADELPHIA 32, PA.

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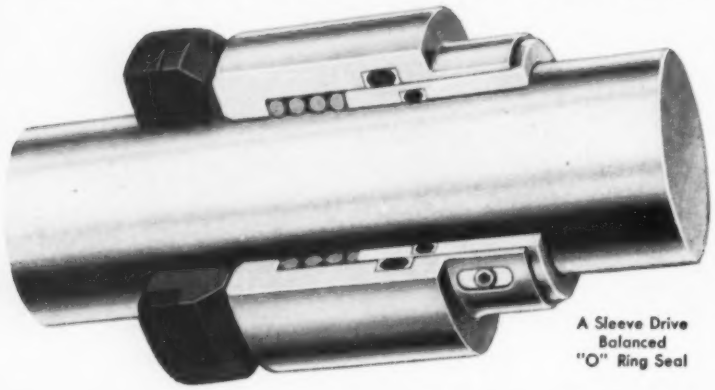
In Mexico: Babcock & Wilcox de Mexico, S. A., Mexico City
In Europe: Recuperation Thermique & Epuration, Paris

Garlock "O"-Ring Seals

FOR ROTATING PUMP SHAFTS



A Sleeve Drive Balanced "O" Ring Seal

Simple in Design, Leakless in Operation

GARLOCK "O" Ring Mechanical Seals are made with a minimum of parts. This simplicity of design affords easy manufacturing adaptability of a Garlock "O" Ring Seal to withstand any liquid, whether mild, harmfully corrosive or extremely hazardous, on rotating pump shafts. The Garlock "O" Ring Balanced Seal will hold pressures up to and over 1000 p.s.i.

The "O" rings are available in "Teflon," Buna-N, Neoprene or Silicone. The metal parts contacting the liquid are available in any suitable metal.

On centrifugal pumps handling chemicals, petroleum products, edible liquids, pulp liquors, and many other liquids Garlock "O" Ring Mechanical Seals are giving outstanding service.

For positive sealing, easy installation and trouble-free service use Garlock "O" Ring Mechanical Seals on your rotating pump shafts. Write us about your sealing problems or contact your Garlock representative.

THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK

In Canada:
The Garlock Packing Company of Canada Ltd., Toronto, Ont.

GARLOCK

PACKINGS, GASKETS, OIL SEALS
MECHANICAL SEALS
RUBBER EXPANSION JOINTS

For more data circle 543 on Post Card

Here and There

(*Continued from page 53*)

churches, schools, stores and everything else that can be thought of are provided for the comfort and convenience of all employees.

For those who may elect to go on foreign service, a few words of caution and counsel might not be amiss. Before going to a foreign country it is well to consult one of the good encyclopedias and learn something of the history of the country, ancient, colonial if Spanish American and modern; its people, and its customs and to consult the annual volume issued by the Americana Corporation. The purchase of a technical dictionary and a dictionary in English and the language of the country is a very valuable item to assist in familiarizing you with at least some of the rudiments of the language.

You cannot change the customs and usages of a people, so you should adopt your living to their established customs and way of life. It is well to avoid all conversation dealing with politics and just be a good listener. There is an old adage: When in Rome, etc. If you do, you will get along.

Chile has been cursed with depreciation of currency and inflation in its most serious form, and if you want to see what has happened to the people as a result of this philosophy of government and currency, you can see very quickly here. In 1910 2.25 pesos were worth one dollar. Today the legal exchange value is 125 to the dollar with the black market quoting 135 to 140. Their income tax philosophy is that the other man always has the money.

Power Operations

Power plant operation in Chile and particularly in the northern or desert zone have water treatment problems. Chilean desert water is extremely hard and high in calcium and magnesium which makes an extremely bad boiler water. Elaborate treatment and evaporating equipment must be used if boiler ratings are to be maintained as well as maintaining continuous operation.

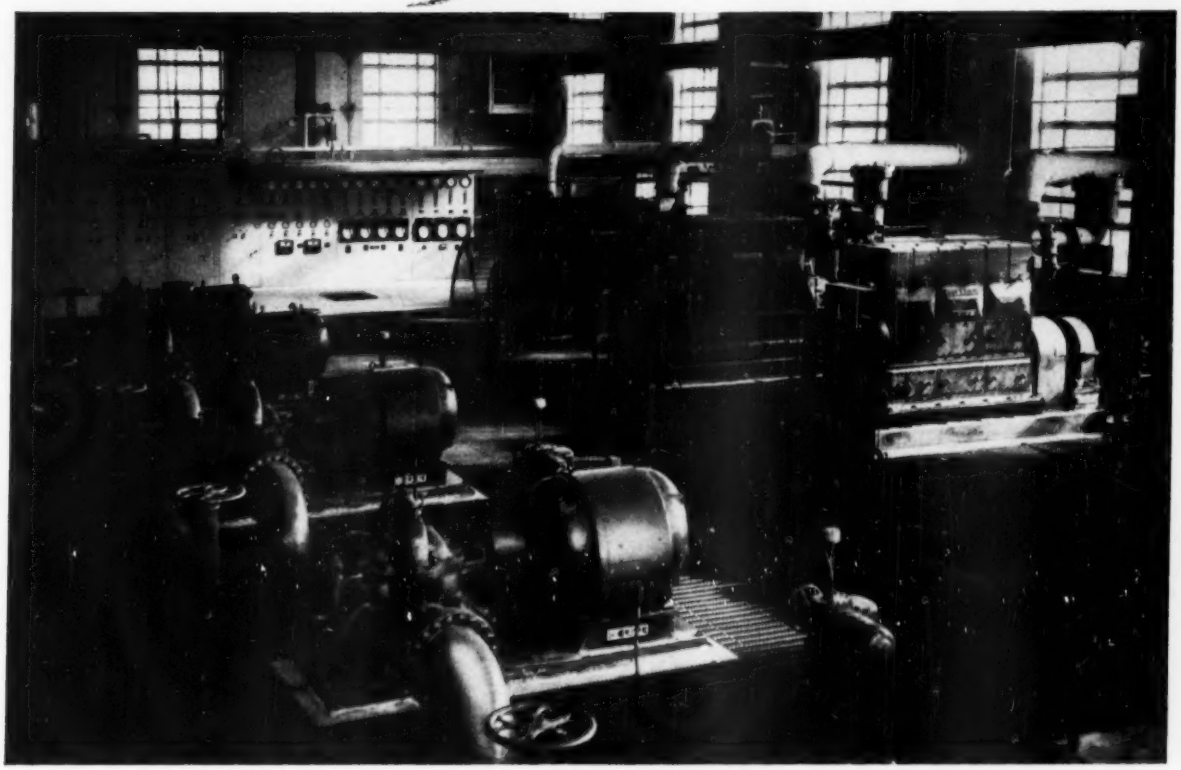
Figure 7 shows the Andes Copper Co. power plant at Barquitta, capacity 30,000 kw, 380 psi, 625 F. From this plant, power is transmitted to smelter and mining camp at Porterillos over a 100-mile, 80,000-v, 50-cycle transmission line.

The Chilean mechanics are unusually well qualified and skilled men and the jobs of welding, pipe fitting and machine work were all anyone could ask for. Likewise they are easy people to get along with providing you don't try to tell them they know nothing and their country is no good, and you have all the answers. One of the various political experiments was the nationalization of the railroads. There are essentially two rail-

(*Continued on page 106*)

DE LAVAL
FIRE PUMPS

on the job at Idlewild



Ten De Laval centrifugal pumps, with a total capacity of 34,000 gpm, play a vital role in the deluge fire-fighting system of the New York International Airport at Idlewild, Long Island.

The installation is composed of two 2,500 gpm and three 4,000 gpm motor-driven pumps as well as two 2,500 gpm and three 4,000 gpm diesel-driven units, which are used for standby service. When the normal operating pressure drops from 165 psi to 140 psi or less, the electric pumps go to work automatically. The diesels are brought into service as necessary.

Efficient De Laval centrifugal pumps are serving water works and fire-fighting stations all over America. These pumps are available in capacities ranging from less than one million gallons per day to more than 100 million gallons per day.

DE LAVAL *Centrifugal Pumps*

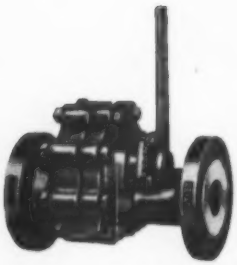
DE LAVAL STEAM TURBINE COMPANY
816 Nottingham Way, Trenton 2, New Jersey

DL 177

For more data circle 544 on Post Card

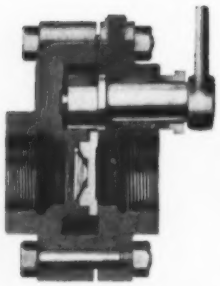
EVERLASTING VALVES

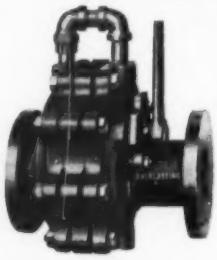
mean "EVERLASTING" PROTECTION on these duties



GENERAL SERVICE

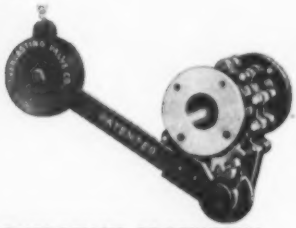
Wherever frequent use and quick operation is required for any liquid or gas at pressures up to 300 psi. These valves have outside stuffing box and gland.





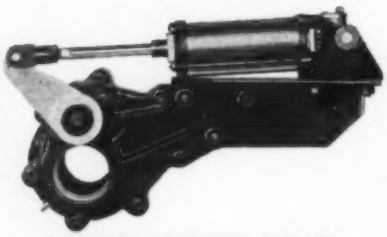
STEAM JACKETED

Assure continued free flow of any material which congeals at ordinary temperatures.



EMERGENCY PROTECTION

Closing type for inflammable liquid emergency shut-off, or opening type for deluge or drainage, assuring immediate and positive action with weighted pendulum stop.



CYLINDER-OPERATED VALVE

for accurate control of process work. Straight-through flow, drop-tight seal, air or hydraulic control for operation at any speed.

EVERLASTING FEATURES

For more than 40 years, EVERLASTING VALVES have been known for their ingenious design, simple sturdy construction, and long trouble-free life with low maintenance expense. Some of their distinctive features are:

Quick Action . . . opened or closed with less than a quarter turn of the operating lever.

Straight-Through Flow . . . the disc cannot become loose and accidentally check the flow.

Drop-Tight Seal . . . constant contact of disc and seat at all times prevents dirt or scale from getting between.

Self Regrinding . . . the disc rotates on the seat with each operation, thus regrinding the sealing surfaces.

No Wedge Action . . . all parts move between parallel faces.

EVERLASTING VALVE COMPANY, 49 FISK STREET, JERSEY CITY 5, N. J.

Everlasting Valves

TRADE MARK "EVERLASTING" REG. U.S. PAT. OFF.

FOR EVERLASTING PROTECTION

For more data circle 545 on Post Card

(Continued from page 104)

road systems, one known as the broadgage from Santiago to Concepcion and Valparaiso. The other system is the narrow or one meter gage rail line to Peru and Bolivia known as the longitudinal. If this country (U.S.A.) has any money to give for the betterment of people in other countries, it could be very well spent in assisting the Chileans in the modernization of the longitudinal. The motive power is very light, the rail is 60 lb. Consequently freight and passenger service moves very slowly in part due to the two items just mentioned plus the fact that at approximately every hundred miles a river flowing from high in the Andes down to the Pacific is encountered. This involves a continuous climb and descent of what they call ridges. The fastest passenger train on this line takes 34 hours to go from Copiapo in the northern zone, 500 miles to Santiago and freight moves slower.

Inca Roads

One of the thrills I got on the trip was to see the Inca road. This highway was built by the Incas in the 14th century from Lima, Peru to Santiago, Chile. It is a marvel of highway construction and location, considering that when the Incas built it they had none of our modern surveying instruments and equipment like tractors. Sections of this road are still in use today and in general the new roads follow routes selected by the Incas hundreds of years ago.

There are two great scenic thrills at night, particularly in the north or desert country. One is the Southern Cross which is so bright in the southern heavens and the other is watching the moon rise over the Andes. At first it is just a ribbon of silver as the moonlight strikes the snow on the mountains and then when the moon comes over the range it is a sight of undescribable beauty.

Manufacturers of equipment desiring to sell in South America should look carefully to those they select to represent them. In many cases they are not too well informed as to the equipment and as to its application, and usually, as a group, they are order grabbers. One complaint of the people in South America is when they write the States, we do not reply in Spanish or Portuguese and that the picture text and descriptions are all in English. There is one outstanding exception, the catalog in both English and Spanish of power plant mechanical goods put out by the Johns-Manville Company. The illustrations are at the top of the page. All dimensions are given in inches and centimeters. The description is half page in English and the other half page in excellent technical Spanish. Some manufacturers attempt to have teachers of Spanish make translations for them and in those cases the people are not acquainted with the technical language,

(Continued on page 108)

A Typical Report of a GRAVER DEAERATING HEATER

GUARANTEE: *Exceeded*

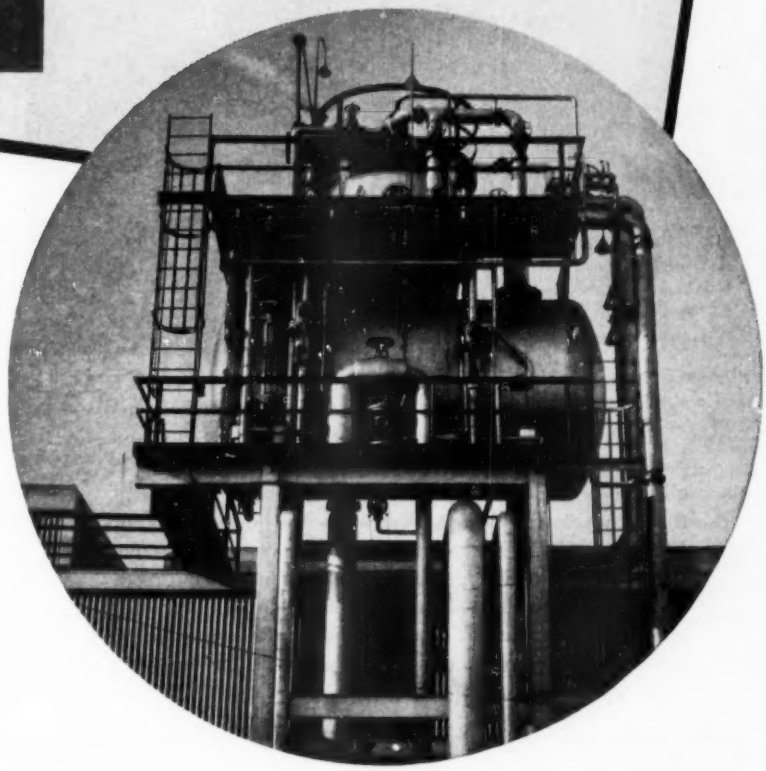
SERVICE: *Excellent*

The installation: A prominent Eastern petroleum refining company.

The unit: Graver Spray-Type Deaerating Heater delivering 450,000 pounds of feedwater per hour to 650 psig waste heat boilers.

The requirements: To remove up to 100 ppm CO_2 and 12 ppm O_2 under all load conditions with water at 60°F. Guarantee - 0.005 ml/l of O_2.

The performance: Average of 0.0047 ml/l of O_2 certified by an independent consulting engineering laboratory, and with completely trouble-free service.



The important point about this report is that it is *typical* of Graver Deaerating Heater performance, even under difficult load variations or water conditions.

Graver Heaters are available in a *complete range* of sizes in spray, tray, or combination spray-tray types. Graver Heaters are individually tailored to your exact plant requirements . . . that's one of the reasons why Graver's guarantee and service can be depended upon.

Write for free copy of "Trends in Application of Deaerating Heaters for Treatment of Boiler Feedwater".

GRAVER WATER CONDITIONING CO.

GRAVER

Division of Graver Tank & Mfg. Co., Inc.

DEPT. PE-H, 216 WEST 14TH STREET, NEW YORK 11, N. Y.

In Canada: The Bird-Archer Co., Ltd.; Cobourg, Ontario

In Mexico: Proveedores Tecnicos, S.A.; Puebla 259, Mexico 7, D. F.

GW461

For more data circle 546 on Post Card

Make boiler water level checking Doubly Sure with Reliance Safety Team

Reliance Alarm Water Column No. W450-C12 and EYE-HYE E901 form the Safety Team at the Philadelphia brewery of C. Schmidt & Sons, Inc.

THE safest way to prevent boiler water level accidents and costly shut-downs is the combination of *visual* and *sound* indications. You're doubly safe when operators can check EYE-HYE's convenient, clear-cut reading right at their control station *augmented* by the alarm on your Reliance Safety Water Column. You don't want that alarm to sound, but it's there, ready to prevent an oversight if gage-reading is delayed. Make *doubly sure* with the Reliance Safety Team. There's a Reliance Representative near you—glad to check your requirements—or write to the factory.

THE RELIANCE GAUGE COLUMN CO., 5902 Carnegie Ave., Cleveland 3, Ohio

The name that introduced safety water columns....in 1884

Reliance®

BOILER SAFETY DEVICES

For more data circle 547 on Post Card

(*Continued from page 106*)

knowing only the literary language, consequently they are anything but satisfactory . . .

There is one thing we do not appreciate in this country and that is our wonderful telephone system. The telephone service in Santiago is excellent, but the long distance service is another story. It requires about five hours to get a telephone call through from Copiapo, the capital of the Province of Atacama, to Santiago. The quality of the transmission is extremely poor and would not be tolerated here in the United States.

In the northern zone of Chile there are no fuels so consequently fuel for operation of power stations and smelters is either fuel oil from Peru or coal from southern Chile. Chile has a length from the Peruvian border to Cape Horn of 2600 miles. The transportation of fuel from the mines located in the southern zone of Chile to the smelters and other operation in the North is a very formidable problem and contributes to a very high cost per metric ton. Coal is of excellent quality however.

Little language trouble is encountered as most of the engineering group speak English, to a limited extent. Spanish, which is the language of the country, is not too difficult to learn. The Chilean engineers are particularly desirous of having you discuss matters with them in English so as to assist them in learning technical terminology. They are very helpful in teaching you Spanish and "Smelter and Power Station Spanish", which will not be found in literary publications.

South America is awakening to a tremendous industrial development. It must be borne in mind when the Spanish Invasion and Colonization of South America, particularly the conquest of Peru, began in 1535 A.D., the Spanish were only interested in gold and silver. This also holds true to their invasion of Chile which began in 1538 and the final colonization of Santiago in 1541. The early Spanish civilization followed the pattern of Spain and it has been only in recent years since the search for metals other than gold began that any real geological exploration of the western side of the Andean range from Ecuador to Chile was really undertaken. What will be found can only be imagined at this time. It is a land of wonderful opportunity for those who will go and give their employers a good day's work.

Power Relief Valve

(*Continued from page 59*)

the gage glass and prepare it for firing. Firing should proceed in accordance with regular instructions, either with oil or intermittent firing of pulverized coal. Firing rate should be controlled to give an average temperature rise of not more than 100 F per hr.

(*Continued on page 110*)

at P. LORILLARD COMPANY, too . . .
Leffel boilers are efficient and money-saving

The two 150 HP, 150# Leffel Scotch boilers installed at the Danville, Virginia, plant of the P. Lorillard Company.

P. Lorillard Company.
TOBACCO-CIGARETTES-CIGARS
119 West 40th Street
New York 18

The James Leffel & Co.
Springfield
Ohio

Gentlemen:

We are operating in our Danville, Virginia plant two of your 150 H.P. Leffel S.M. Boilers.

These boilers have certainly performed very satisfactorily since their installation last June since which time we have been operating them 10 to 20 hours per day.

We have found these boilers to be very economical and quick and steady steamers.

Besides building an excellent product, we found your company courteous and cooperative in every way.

Very truly yours,

Director of Leaf Activities

IPH:SS

Leffel Scotch Boilers will prove ideal for you, as they have for Lorillard, because they never let you down when called on for capacity beyond their rating. A Leffel boiler can produce double its rated capacity in emergencies, with complete safety and without injury to the boiler. It can run continuously at fifty percent above its rating.

A Leffel boiler is bigger—heavier—much longer lived—stronger than the ordinary boiler of the same rating. Nothing in it is shaved to meet a price. (Yet it *is* competitively priced.)

That's why Leffel boilers hold up so well under rugged use. That's why they are so free from excessive operation cost.

Your Leffel boiler comes complete with all controls. Installation is easy and fast. Just set it, hook it up, and put it to work. And it's just as easy and economical to operate. Users report fuel savings up to 40 percent.

Models for coal firing, by hand or stoker, and gas and oil. All are easily convertible to any other fuel. 6 to 250 HP.

Let Leffel engineers help *you* get the most from your boiler dollar. Write for Bulletin 236. It's a mine of information.

Sheet 1-30-52

FOUNDED IN 1862

THE JAMES LEFFEL & CO.

DEPT. A, SPRINGFIELD, OHIO, U. S. A.

MORE EFFICIENT STEAM GENERATION FOR 91 YEARS

For more data circle 548 on Post Card

Chesterton *Centrifo*

THE CENTRIFUGAL PACKING *that spares the rod without spoiling the seal*

"Centrifo" is a soft, highly lubricated packing made from the silkiest of cotton fibres. As it tends, blotter like, to absorb the liquid which it seals, it always remains soft and pliable. It won't score brass shafts, sleeves or rods even at speeds up to 4000 rpm.

Chesterton Centrifo gives a packing seal superior to square flax or braided asbestos on centrifugal or rotary pumps handling hot or cold water, brine or cold oil.

To spare the rod without spoiling the seal specify Chesterton Centrifo. Order today from your Industrial Jobber and observe how "Centrifo" holds the seal and eliminates expensive pump repairs.

PACKING Chesterton SERVICE

A. W. CHESTERTON CO.
6 Ashland St., Everett 49, Mass.

☐ Send me a free sample of Centrifo Packing.

☐ Who is my distributor?

Name_____ Company_____

Street_____

City_____ State_____

For more data circle 549 on Post Card

(*Continued from page 108*)

When pressure on the drum reaches 15 lb close all open vents and drains, and continue firing procedures until drum pressure of 300 to 350 lb is reached.

With this drum pressure operate the power-operated valve for 10 sec, just before starting coal firing; and again for 25 sec, 5 min after coal firing starts. If this second operation drops drum pressure 20 lb below that showing just before the valve is opened it indicates the superheater is cleared of water. If drum pressure does not drop 20 lb it indicates the superheater is not cleared, and the above procedure should be repeated at the next period of coal firing, or in 20 min.

With the superheater cleared, continue firing intermittently until pressure reaches about 650 lb, at which time the above mentioned operation of the power-operated relief valve should be repeated, and after which the boiler can be brought up to pressure and put in service.

Firing Up Banked Boiler

If pressure on the boiler is about 600 lb or above, proceed the same as if pressure had reached this point in firing up of a cold boiler.

If pressure is below 550 lb operate the power relief valve immediately for 10 sec, after lighting oil torches; and again for 25 sec, 5 min after coal firing starts. From this point on proceed the same as if pressure had reached this point in firing up a cold boiler.

Figure 2 is a graph derived from records obtained when firing up a banked boiler, and Fig. 3 shows the gage board used in making the test. The small electric bulb between the gages was connected to the control circuit of the relief valve so that the movie record shows when the valve was opened and closed. Figures 4 and 5 show the location of the valve, respectively.

Arrangement for tests in firing up a cold boiler was the same except that test gages were installed below the clock to show pressures from 0 to 600 lb, since board gages do not read below that point.

As a result of these tests and the experience at this plant, the above procedure for firing up high-pressure, high-temperature boilers has been adopted at all plants of the company with which I am associated.

Elimination of the continuous venting by substituting use of the power-operated relief valve has not only eliminated all overheating of superheater elements, but has also shown a reduction in fuel required for firing up and a saving of pure water.

Other designs of boilers operated at higher pressures might call for some modification of the procedure, but the principle of surging water from the superheater elements should be applicable to any high-pressure steam generator.

Excitation Systems

(*Continued from page 61*)

necessary, the machine can be manually tripped from the line.

Perhaps the most important relay applied in synchronous machine field circuits is the field ground detector relay. One terminal of the relay coil is connected to the negative field terminal. The other terminal of the relay coil is connected to the positive side of a continually energized full wave rectifier, the negative side of which is grounded. Normally, no current flows through the coil, but upon the occurrence of a ground in the field circuit the relay circuit is completed and the rectifier forces current through the relay coil. The latter then provides an alarm to indicate to the operator that a ground has appeared.

A machine should be removed from service when the field is known to be grounded. Although one ground in the field circuit will not affect the supply of field current to the synchronous machine, the danger then exists that a second ground may appear. The development of the second ground is likely to unbalance the magnetic forces in the rotor so that serious vibrations will occur. Machines have been known to pull loose from their foundations upon the occurrence of a second ground in the field circuit.

Undervoltage Protection

Another relay function in the excitation system is that of undervoltage. Reduction of the voltage across the field of a machine below some minimum value will encroach upon the stability margin of the machine. A further reduction will cause a lowering of system voltages so that the stability of other machines is threatened. In addition, a complete loss of field voltage will cause the machine to run as an induction machine with rapid overheating of the rotor wedges.

An undervoltage or undercurrent relay is sometimes applied in the main field circuit for alarm purposes. In case of operation of this relay the operator attempts to bring the machine excitation back to normal and, in the case where this cannot be immediately accomplished, trips the machine off the line. These relays are commonly used only for alarm since the settings cannot be made sufficiently precise to differentiate properly between underexcited operation and actual loss of field.

The minimum excitation limit of the voltage regulator provides a measure of undervoltage protection. With the regulator in control of the exciter, the limit prevents a reduction in field voltage below some minimum safe value.

The best method of protection is the employment of a loss of excitation relay. This is a distance type or mho relay which is applied at the synchronous machine terminals. The re-

(*Continued on page 112*)

RUSSO is a compressible sheet that will make up tight and stay tight. Its homogeneous construction of long asbestos fibers permits easy and true cutting into gaskets. Complete graphite impregnation to prevent flange adherence and heat resisting binder to take years of punishment. When you want to be sure of a joint; be certain to specify Chesterton RUSSO.

PACKING Chesterton SERVICE

A. W. CHESTERTON CO., 6 Ashland St., Everett 49, Mass.

☐ I would like more data on "210"
☐ Who is my local distributor?

Name _____
Company _____
Street _____
City _____ State _____

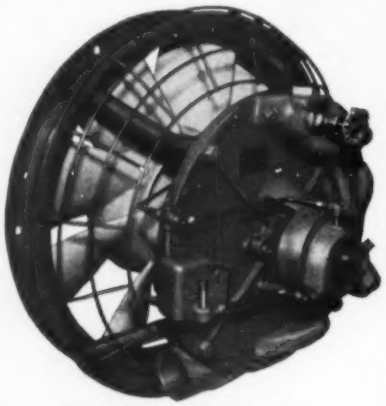
For more data circle 550 on Post Card

A COMPACT Turbine Blower Installation

Here is an example of the adaptability of the Wing Turbine Blower to the limitations of restricted space. Additional boiler installations at the E. R. Squibb & Sons, New Brunswick, N. J., plant left little space for auxiliary equipment. As the photograph shows, the complete Wing turbine and blower (47,000 CFM, at 5" s.p., at 1850 RPM) were placed beneath the rear boiler overhang and occupy a space but 54" in dia. by 33" high! (Another Wing unit occupies a similar space 45"x30".)

Compact design is but one of the many superiorities of the Wing Turbine Blower. In addition, they are quiet, rugged in construction, economical in operation and in maintenance. Wing Turbine Blowers cost nothing as a source of power when the oil free exhaust steam is used for process work, space heating or other uses requiring low pressure steam.

WING MOTOR DRIVEN Axial Flow BLOWERS are used on many of the country's leading makes of boilers as standard equipment. The reason lies in the consistently satisfactory performance they have been delivering for over half-a-century—plus the outstanding features of WING design, such as volume control (Voltrol Vanes) for capacity regulation down to 90%, ease of installation, quiet operation, compact construction, low maintenance cost. Wing Motor Driven Blowers give day-in-day-out, year-in-year-out satisfaction.



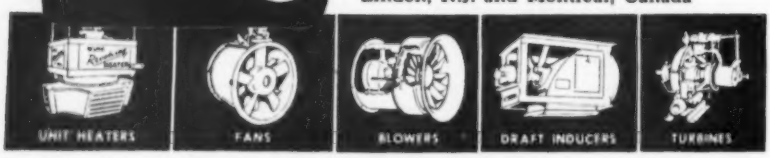
Type R Wing Turbine Blower

Write for a copy of Wing Bulletin SW-52

Wing

L. J. Wing Mfg. Co.

64 Vreeland Mills Road
Linden, New Jersey
Factories:
Linden, N.J. and Montreal, Canada



For more data circle 551 on Post Card

(Continued from page 111)

lay is responsive to certain relationships between the a-c voltages and currents which occur during a loss of field condition. It is set so that it is not sensitive to fault currents, power swings, or unusual operating conditions. Because it can be set with precision, it can be used to trip the machine from the line.

Excitation Cubicle

A cubicle can be provided to house the entire excitation equipment with the exception of the exciter. This cubicle has a standard metal-clad exterior appearance, and permits the location in one place of the excitation equipment. A view of an excitation cubicle is shown in Fig. 4.

A typical arrangement might consist of three sections of metal-enclosed structure. These are: a section including up to two electrically-operated field switches and field discharge resistors, a section containing the panels of the voltage regulator, and a section including the amplidyne mounted at floor level and the exciter field rheostat mounted on a platform or shelf above the amplidyne. More than three sections can be included where necessary to house additional field switches, rheostats, or voltage regulators.

A somewhat similar cubicle can be provided to house the excitation equipment when using an indirect acting rheostatic type voltage regulator. Although the regulating head is conventionally mounted on the station control board, the remainder of the excitation equipment including the Wheatstone bridge rheostat and field switches can be mounted in the cubicle.

The interior of the cubicle is made accessible by means of doors on the front and hinged or bolted panels on the side and in the rear.

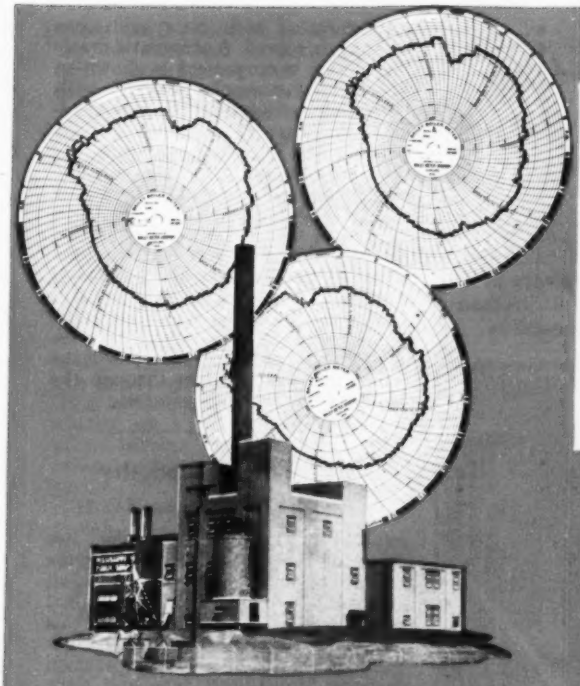
Normally, all control for the excitation equipment is remote from the cubicle. However, local control devices can be added for testing or other purposes.

System Layout

In addition to the listings in Table I, there are included in each case meters and relays as required.

With the use of a spare exciter, the connections become more involved and additional equipment must be added. A second field switch must be connected to the field of each machine which may be supplied from a spare exciter. The discharge contacts of both switches are connected in series with the discharge resistor so that the latter is connected across the field when both switches are open. Each exciter is supplied with its own field rheostat.

Common practice is to operate the spare exciter on hand control. However, in several recent installations with the amplidyne voltage regulator, switching arrangements have been provided so as to control the spare exciter by means of the regula-



CONSISTENT EFFICIENCY

AT ALL LOADS

with Detroit Stokers at Mississippi Valley Public Service Company, Winona, Minnesota

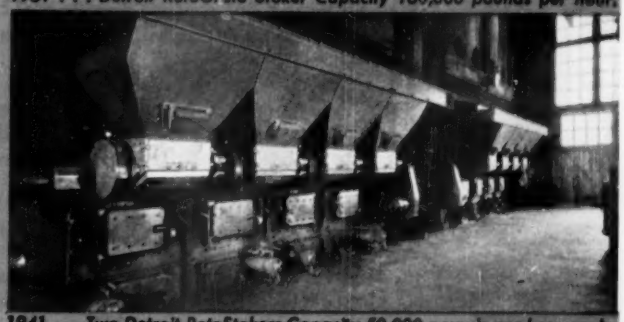
To meet increased demands for power, Mississippi Valley Public Service Company of Winona, Minnesota, added a new 160,000 pound per hour unit in 1951. It was only natural that a Detroit RotoGrate Stoker was selected for this larger boiler after their successful operation of 50,000 pound capacity Detroit RotoStokers installed ten years previously.

The new Retograte has proved thoroughly dependable. It is efficient at any load and fluctuations are handled without appreciable pressure drop.

Detroit Spreader Stokers have built up a reputation for high efficiency and exceptional dependability since first introduced in 1931. They burn any Bituminous coal or Lignite without special preparation. Little power is required for operation . . . maintenance costs are low . . . availability is high.

There is a type and size Detroit Stoker to save you money and improve your operation. Let us make recommendations—no obligation.

1951 . . . Detroit RotoGrate Stoker Capacity 160,000 pounds per hour.



1941 . . . Two Detroit RotoStokers Capacity 50,000 pounds per hour each.

DETROIT STOKER COMPANY

GENERAL MOTORS BUILDING • DETROIT 2, MICHIGAN

Works at Monroe, Michigan • District Offices in Principal Cities

DETROIT SINCE 1898 STOKERS

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Delaware Power & Light

specifies

Richardson

Like many progressive utilities, Delaware Power & Light Company selected Richardson Automatic Coal Scales to maintain a constant check on boiler efficiency in their new generating station. The bank of Richardson Model 39's shown now handles this responsibility.

To both industrial and utility power generating stations, specifying Richardson means—

1. A 24" x 24" inlet opening and 26" wide belt for maximum coal flowability.
2. All wiring and controls outside coal chamber.
3. Access doors which will not spill dust on floor when opened.
4. Beam ratio test facilities outside coal chamber.
5. Gravity operated by-pass, with no restriction of coal flow to downspout.
6. No drag links or wires attached to weigh hopper.
7. Nationwide after-delivery service.

Latest development in the 39 Series of Richardson Automatic Coal Scales is the Model H-39 shown above. May we send you our new 16-page engineering data book on the H-39 Coal Scale (Bulletin 0352), without cost or obligation?

RICHARDSON SCALE COMPANY · Clifton, New Jersey

Atlanta • Buffalo • Boston • Chicago • Detroit • Houston
Minneapolis • New York • Omaha • Philadelphia • Pittsburgh
San Francisco • Wichita • Montreal • Toronto

8780

Richardson

MATERIALS HANDLING BY WEIGHT SINCE 1902

For more data circle 553 on Post Card

tor associated with the synchronous machine involved. A schematic drawing of this arrangement is shown in Fig. 5. For normal operation with both main exciters, amplidyne transfer contactors "A" and "B" are picked up. The transfer from the main to the spare exciter is made under manual control. Following the transfer, contactor "C" or "D" can be picked up to connect the proper amplidyne into the spare exciter field circuit. The only additional items of equipment required are the two extra transfer contactors. Shown in the figure are the four main field switches. Also shown are the connections of the field discharge resistors through the contacts on the field switches.

Gas Turbine in Industry

(Continued from page 65)

cated just ahead of the boiler. Because of the large amount of excess air approximately 450 per cent: used in the gas-turbine cycle, no additional air is required for combustion of this supplementary fuel. This further simplifies the installation and operation because forced-draft fans and their attendant controls are not required.

Depending on the balance between electric power and steam requirements, supplementary firing might be used continuously to increase the output of the exhaust-heat recovery boilers to relieve the demand on conventional fuel-fired boilers. In other applications, supplementary firing might be used to supply occasional peaks in steam load.

In still other plants, supplementary firing might be used during an outage of conventional fuel-fired boilers. Output of the exhaust-heat recovery boilers can easily be doubled or tripled — say from 40,000 to 80,000 or 120,000 lb per hr steam flow — by supplementary firing. This being the case, the capacity of fuel-fired boilers normally maintained as stand-by can be materially reduced with the attendant reduction in first cost and fixed charges.

Turbine Exhaust Gases as Combustion Air for Fuel-Fired Boilers: — High gas-turbine cycle efficiencies can also be realized in plants where the combustion gas-turbine exhaust gases can be used as combustion air for fuel-fired boilers. Because of the large amount of excess air used in the gas-turbine cycle to limit temperatures, the turbine exhaust contains approximately 17 per cent oxygen compared to 21 per cent for free air. Because so much oxygen is left in the exhaust gases, they can be used as preheated combustion air for fuel-fired boilers which are not equipped with air heaters. One 4000-kw gas turbine can supply combustion air required by a fuel-fired boiler having an output of approximately 250,000 pounds of steam per hour. This cycle arrangement is shown in Fig. 6.

When the gas-turbine exhaust

gases can be utilized as combustion air for fuel-fired boilers equipped with economizers, the gas-turbine plant cycle efficiency can be as high as 80 per cent when credited with heat in the exhaust gases. For the same per cent excess air in the fuel-fired boilers, boiler stack losses will be slightly higher when gas-turbine exhaust gases are used for combustion air.

Steam or Gas Turbine—Which?

When the gas turbine is credited with the heat in its exhaust gases which can be recovered for various uses in industry, its cycle efficiency can be as high as 70 per cent or more. This is comparable to the cycle efficiency of a good noncondensing steam-turbine plant used to "top" other turbines or to supply steam for process use.

How then can we select the proper cycle?

Referring again to Fig. 1, this curve shows that steam turbines should be considered when the ratio of electric power to process steam is low — say 2500 to 5000 kw per 100,000 lb per hr steam flow which is 20 to 40 lb of process steam per kwh. Gas turbines should be considered when the ratio of electric power to process steam is high — say 8000 to 10,000 kw per 100,000 lb per hr steam flow which is 10 to 12 lb process steam per kwh.

In the intermediate range of process steam requirements, the condensing-extraction turbine, the gas turbine utilizing exhaust-heat recovery boilers with supplementary firing, or a combination of the two may be selected.

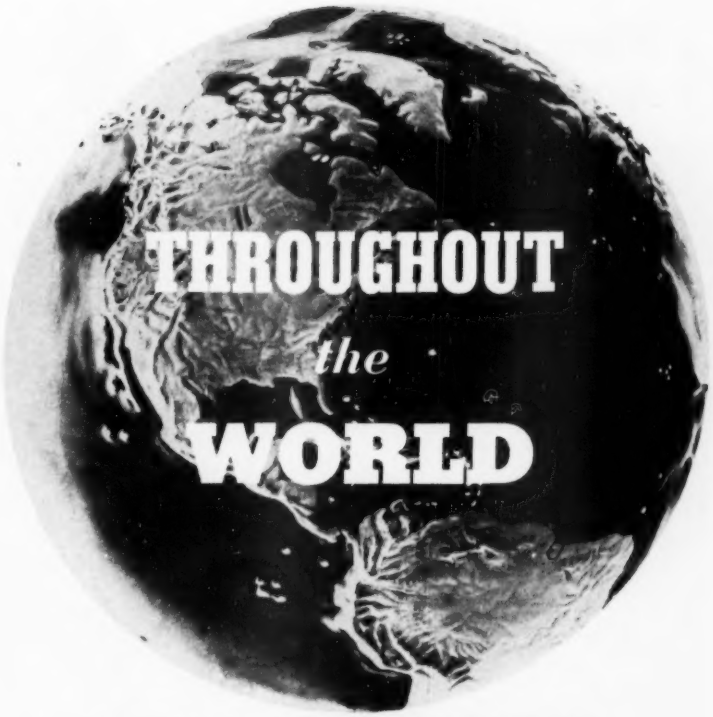
This ratio of process steam per kilowatt-hour varies widely. The over-all average in industrial plants having use for process steam is perhaps no more than 25 lb per kwh and, with the rapid increase in the use of electric power, the ratio is likely to decrease still more in the future. In some new plants and particularly in the expansion of existing plants, the ratio of process steam to electric power requirements may be quite low. A low ratio favors the gas turbine.

Selection of Fuel

Much effort is being expended at the present time to develop means of using a wide variety of fuels for the combustion gas turbine. Based on experience to date, gas or distillate oils are excellent fuels. No doubt, in the future, satisfactory equipment will be developed so other fuels can be used commercially. At the present time, the steam-turbine plant can utilize a much wider variety of fuels.

This is a handicap for the gas turbine in areas where the cost of suitable fuel is higher than that of fuels for other power plants.

This handicap is partially overcome by the greater simplicity and lower installed cost for the gas turbine. In areas where the same fuel



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would not be used in the different types of power plants, the relative fuel costs must be considered simultaneously with the plant thermal efficiency. In plants where the same fuel would be used, relative plant thermal efficiency is a direct measure of relative fuel costs.

Gas Turbine vs Steam Turbine

Let's make a few comparisons between the gas-turbine and the steam-turbine plant.

Initial Cost :— From available data, it is estimated that cost of a new gas-turbine plant is approximately three-fourths that of a comparable steam plant.

However, each case should be carefully studied by competent engineers so accurate and complete installation and operating costs are established. With such information the proper selection of the source of power can be made whether this be purchased power or local generation or a combination.

Control: — The gas-turbine plant has one simple control panel. The simplicity of this plant makes complete automatic control practical.

Efficiency: — When properly applied — both steam and gas turbines operate with high cycle efficiencies (the gas turbine when ratio of electric energy to heat energy is high — the steam turbine when this ratio is low.)

Reliability and Maintenance: — A total of more than 60,000 hours of operation have been accumulated on the gas turbines now in service. Even though this is equivalent to more than 6 years of operation, it is realized that an accurate prediction of reliability and maintenance cannot be based on this relatively short period of operation. However, the designers are confident that the gas-turbine plant will compare favorably with the steam-turbine plant. It might be well to point out here that the combustion gas turbines for commercial land applications are designed with safety factors comparable to those used in steam turbine design so far as long life and low maintenance are concerned.

Chloride Deionization

(Continued from page 68)

Exchange capacities of 5–10 kilograins exchangeable anions per cu ft of resin have been reported. Marked improvement in capacity has been noted when sodium hydroxide is used with sodium chloride in the regenerating solution. This combination has been known to increase exchange capacity up to 50 per cent.

The same standards in evaluating exchange capacity of resins have not always been used, resulting in conflicting information. To compare such data, they should be obtained under the same leakage standards. For example, on raw water of initially low

(Continued on page 118)

Double Drainage Capacity with Clark DUO-STEP Traps

Engineers know that the effective drainage of condensate from steam lines is a matter of trap capacity. How much condensate can a steam trap of a given size drain in a specific time? The more it can drain the more efficient the trap.

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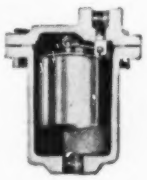
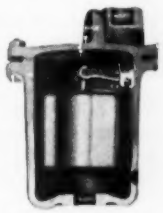


CLARK "701"-D (DUO-STEP) TRAP. A forged steel trap for pressures up to 500 P.S.I. and temperatures of 750°F. Equipped with "double-drainage" Duo-Step Leverage and Venting, Clark-loy seats and discs. Pipe sizes ½" or ¾".



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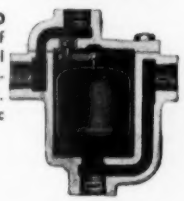

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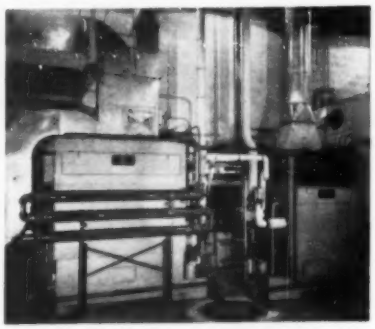

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(Continued from page 117)

alkalinity, such as 30 ppm, if the unit were operated until alkalinity reached 15 ppm, a high exchange value would be obtained. On the other hand, if raw water alkalinity were 200 ppm, and the run again terminated at 15 ppm, exchange capacity would be lower than in the first case.

One manufacturer states that average alkalinity of effluent will be 8 ppm as $CaCO_3$, or 5–10 per cent of influent alkalinity, whichever is greater. Another says average alkalinity of the effluent will not exceed 5 per cent of influent alkalinity, with not more than 10 per cent leakage at the end of the run.

It is theoretically possible to design a single unit in which both sodium zeolite softening and chloride anion exchange take place. However, due to various technical problems, it seems unlikely that such a design will be desirable.

General Conclusions

Sufficient operating data on this new process are not yet available to predict the exact niche this means of dealkalization will occupy. As additional installations are made, additional data will become available.

Major usefulness will be in relatively small plants where hazard of acid handling is a controlling factor in deciding type of external process to be used. In larger installations operating cost with direct acid feeding or hydrogen zeolite will be less than with chloride anion exchangers. In addition, hot lime-hot zeolite may prove more economical in larger plants.

Another element which will affect popularity of this new process is that bicarbonate alkalinity is reduced, but not totally removed. Dependent upon the type of equipment in which steam is condensed and stratification of carbon dioxide in condensing equipment, severe corrosion problems can result even with relatively low CO_2 concentrations in steam.

Corrosion Corrected

When such corrosive condition was corrected by the use of filming amines, it was found that use of acid feed could be discontinued without increasing corrosion potential. Unlike neutralizing amines, it is necessary to use only sufficient filming amines to provide non-wettable metal surfaces. Consequently, with high carbon dioxide content of steam and satisfactory corrosion control with filming amines, installation of a chloride anion exchanger to lower carbon dioxide would not necessarily permit reduction in amine feed rate.

Where neutralizing amines are used, a chloride anion exchanger may permit economy, since reduction in CO_2 content of steam will be reflected in less use of neutralizing amine.

Without doubt, however, this new process offers interesting possibilities in the design of feedwater conditioning systems.

Chimneys – Smoke Control

(*Continued from page 83*)

in the breeching, (11) draft loss through the fuel bed, (12) draft loss through the boiler and setting, (13) draft loss through recuperators, and (14) quantity of gases to be handled. Every one of these factors affects the chimney size appreciably. Obviously the required size cannot be picked from a chimney size based only on boiler horsepowers except by pure chance.

Equation (4) gives the required diameter (D_r) of a natural-draft chimney with a circular section as derived from the equation for a perfect gas.

Equation (5) for the required height (H_r) is derived from the draft-delivery relationship by assuming $D_s + D_{stb}$ (the total dynamic draft) and $L = H$.

All the factors in both equations, with the exception of the chimney-gas velocity, have numerical values that can be ascertained. As a typical example, let it be assumed that the size of a new chimney for the operating conditions noted in the previous example, with the additional information that the total dynamic draft of the external system has been calculated at 1.21 in. w g and the maximum quantity of gases to be delivered is 116 lb per sec, is to be determined. Substituting the proper values in equation (4) for the required diameter and reducing, we get equation (6).

Also substituting the proper values in equation (5) for the required height and reducing, we get equation (7).

From these two partially evaluated equations, (6) and (7), it will be seen that the required diameter varies as the square root and the required height as the 5/2 power of the chimney-gas velocity. Figure 2 shows the variation in the required diameter and height for various chimney-gas velocities.

Conclusions

The curves disclose the fact that, for any assumed group of operating conditions, there will be as many possible chimney sizes, that is, combinations of required height and corresponding diameter, as there are values of chimney-gas velocities to be assumed. Each size will operate in accordance with the requirements demanded of it and for which the size was calculated, each size creating 1.21 in. w g available draft to overcome an equivalent intensity of total dynamic draft when delivering 116 lb of gases per sec.

The question now arises: "Which chimney size to select?" This will be discussed in detail in a future article, which shows how the data on chimney performance given above can form the basis for developing a table of economical chimney sizes based on sound reasoning.

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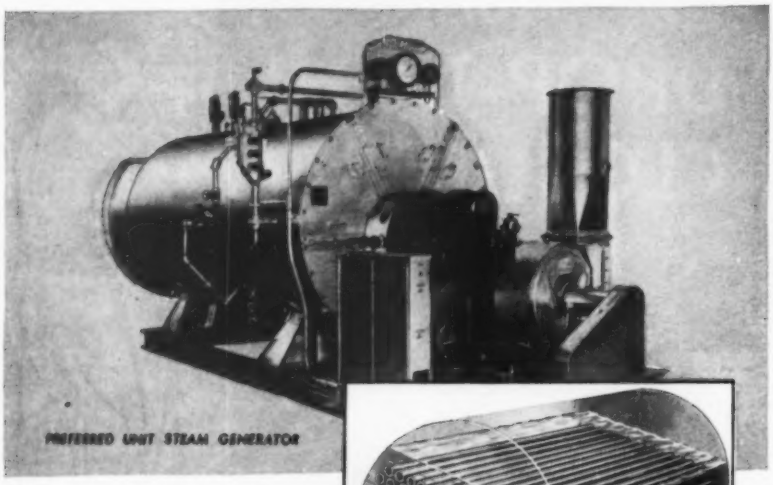

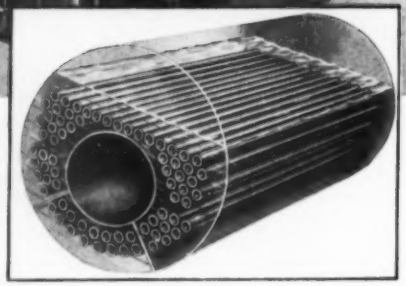

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AIEE Meeting

(*Continued from page 86*)

showing that, curiously enough, the United States deposits in Colorado rank second in importance. The Belgian Congo deposits rank first. They are not only the richest, but also the most extensive.

The amount of uranium in the world is best described in terms of the "Q". Q is an arbitrary unit equivalent to 10^{18} Btu. When we consider the entire coal deposits of the world, we can account for only 70 Q. In the uranium deposits, if we consider only the U235 which of course represents only $\frac{7}{10}$ of 1 per cent of natural uranium, the uranium in the world is equal to only 12 Q. Compared to the 70 Q of coal, it is obvious that this 12 Q would not be of great interest to power engineers. But, if we also use the U238 in uranium by means of the breeding process, then the world's uranium supply is equivalent to 1600 Q. This takes no account of the amount of thorium in the world which, through the breeding process, might also be converted into useful fissionable material.

"Breeding or Bust"

Thus, it will be evident that if the breeding process works, and there are some indications that it will, the power that we may be able to extract from our uranium deposits make our extensive coal deposits seem quite small. Mr. Menke said that the Detroit-Dow plans for utilizing nuclear power are all based on breeding. With Dow-Detroit, as he put it, it is breeding or bust.

Another session of intense general interest was the one on Wednesday afternoon, devoted to the consideration of electrostatic hazards in hospital operating rooms. This session comprised three papers. The first by Robin Beach, of Robin Beach Associates, devoted to the engineering aspects of operating room construction and methods for reducing the hazards due to electrification. The second paper on electrostatic problems in hospital operating rooms and their resolution, was by Dr. C. W. Walter of the Peter Bent Brigham Hospital in Boston. Finally, there was a spectacular demonstration showing how electrostatic explosions occur in hospital operating rooms by Dr. P. G. Guest, Bureau of Mines.

Many of the gases and papers used in anesthesia form explosive mixtures with oxygen or air. While fires and explosions of these mixtures, during surgical operations are comparatively rare, nevertheless those that do occur are vitally important and every known precaution should be exercised to avoid them. Obvious sources of ignition such as sparks and arcs from electrical equipment are well recognized by hospital personnel but a source of ignition not so obvious is *static* electricity. Until quite recently,

(*Continued on page 122*)

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(Continued from page 120)

the presence of this hazard in a large majority of anesthetizing areas was not even suspected. Sparks from static electricity occur from the rubbing of clothing or sheets caused by sudden movements of the operating room personnel.

In the latter part of 1948, several anesthetic explosions were reported in the newspapers and, as a consequence, the U. S. Department of the Interior, through the Explosives and Physical Science Division of the Bureau of Mines, immediately sought and obtained the co-operation of the Anesthesia Department of the University of Pittsburgh School of Medicine and a considerable number of hospitals in the Pittsburgh area. One result of this research, was the development by Dr. P. G. Guest of equipment in miniature, as shown in Fig. 3, to illustrate some of the findings of their investigation. The demonstration was dramatic, showed how very little actual energy is needed to ignite the combustible gases used in anesthesia.

The techniques suggested for combating the hazards due to static electricity in hospital operating rooms, are of course equally applicable in the reduction of static hazards in industrial plants.

Electronic Complexity

Of interest to both communication and power engineers alike, was the session on the complexity of electronic systems. There has been a growing feeling that much of the electronic equipment being used in the military services is becoming too complex to permit proper maintenance and servicing. While there was no question at this meeting that equipment was becoming extremely complex, at the same time, there did not seem to be much hope of reducing this complexity. Rather, the feeling was that many of the failures in electronic equipment were due not so much to its complexity but to too rapid development and insufficient care in its manufacture.

Several sessions were devoted to a discussion of computors of various kinds, but the session that probably was of greatest interest to power engineers, was the one dealing with non-calculative applications of computors. For example, in the control of complex industrial systems, such as petroleum refining, computing machinery is coming into more general use.

One field, which probably will see increased applications of computing equipment, is in the public utility field for control of system load. Modern utility systems are becoming so complex that it is becoming impossible for operators to properly allocate generating units and generating stations as the system load varies. For example, the problem presented by the Northwest Power Pool is being studied, at present, at MIT. The operation of this vast system involves

not only power generation and distribution, but also flood control and irrigation requirements. It is felt that the operation of such a vast system, with so many ramifications, will almost inevitably lead to control by computing equipment.

Of particular interest to the switchgear engineers was the description of a new high voltage outdoor load interrupter switch using sulfur hexafluoride as the quenching medium. The results of investigation into the uses of sulfur hexafluoride gas were revealed by three Westinghouse Electric Corp. engineers, H. J. Lingle of East Pittsburgh and A. P. Strom and P. E. Browne, Jr., both of Trafford, Pennsylvania. Sulfur hexafluoride, they said, is stable and remarkably superior to air in dielectric strength. Indeed, the alternating current interrupting ability of plain-break arcs in SF_6 is in the order of 100 times that of similar arcs in air.

The new switch was described by H. J. Lingal and J. B. Owns both of Westinghouse. The switch is used to interrupt line charging currents, transformer magnetizing currents, and load currents at transmission voltages. The switch is used at locations where a circuit breaker, having proper fault interrupting ability, may not be justified economically.

In his address at the general session, Donald Quarles, President of the AIEE, reported that the Institute membership had just passed the 45000 mark, making it the largest engineering society in the world. Before the close of the meeting, Elgin B. Robertson, President of Elgin B. Robertson incorporated, of Dallas, Texas, was nominated for the Presidency of the Institute.

New ENGINEERING BOOKS

Fluid Flow in Pipes by Clifford McClain; size 6 by 9 in.; 123 pp; illustrated; cloth bound; published by The Industrial Press, 148 Lafayette St., New York 16, N. Y.; price $3.00.

This book can be helpful to both the student and the engineer. For a better understanding of the material, a knowledge of elementary algebra is recommended. While advanced mathematics come in handy in comprehending the development of formulas.

The book begins with dimensional analysis and then goes into density and specific weight, gas laws, mean velocity of flow in pipe and other topics to complete the section called dimensions of fluid properties.

A discussion on the viscosity of fluids, its theory, measurement and dimensions follows. Some of the subjects included in

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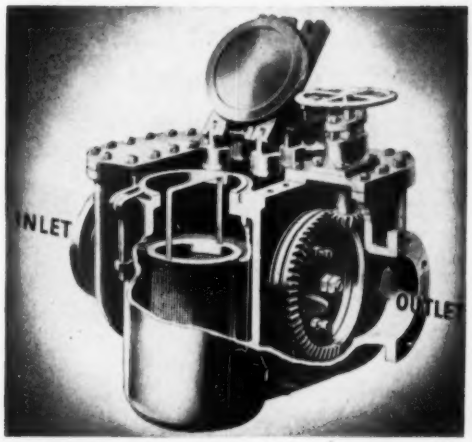

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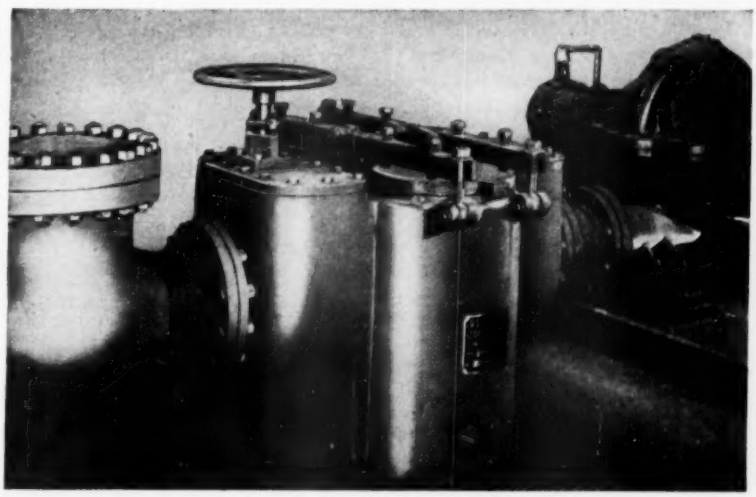

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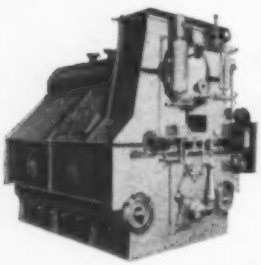

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146

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this portion are consistent units of absolute viscosity, viscous flow in a capillary tube and numerical values of viscosity.

The section on piping effect on flow presents several charts. One of these is Pigott's pipe friction chart. This shows Reynold's number plotted against friction factors.

The last section covers piping design. Here, Bernouilli's theorem is considered with its application. A diagram helps clarify this theorem.

A total of 22 worked-out examples employing various principles appear in different sections of the book.

★ ★ ★

Jordans Dictionary of Civil Defense; size 5 by 7¼ in.; 160 pp; illustrated; cloth bound; published by Philosophical Library Inc., 15 East 40th St., New York 16, N. Y.; price $2.75.

This book presents and explains a list of terms that are associated with civil defense in time of war. However, much of this information can be of use under other emergency conditions.

The nomenclature in this book includes the subject of atomic energy. The coverage of first aid includes a diagram of the human body showing pressure points which can be used to stop arterial bleeding.

Consideration is given to fire fighting and fire control. In the back portion of the book is presented an extensive chart on war gases. This covers their properties, effects and first aid.

★ ★ ★

Bolt, Nut and Rivet Standards; second edition; size 5¼ by 8½ in.; 247 pp; cloth bound; published by Industrial Fasteners Institute, 3648 Euclid Avenue, Cleveland 15, Ohio.; price $3.00.

Contents of this revised edition have been increased and include all the current standards for commercial fasteners. The book presents information that is useful not only to manufacturers but also to users of fasteners.

Nomenclature, dimensions, sizes and formulas are given in this publication. Also included are material specifications, manufacturing processes and weights per hundred.

Some of the new standards found in this book are those of the square and hexagon nuts that have been newly unified dimensionally with Great Britain and Canada.

★ ★ ★

The Engine Indicator by J. D. Hines; size 5 by 7⅜ in.; 53 pp; illustrated; paper bound; published by The Cooper-Bessemer Corporation, Mount Vernon, Ohio; price $1.50.

This comprehensive booklet has been prepared to assist operators of gas and diesel engines in keeping equipment at top operating efficiency by the use of the engine indicator.

It reviews the various types of engine

(Continued on page 126)

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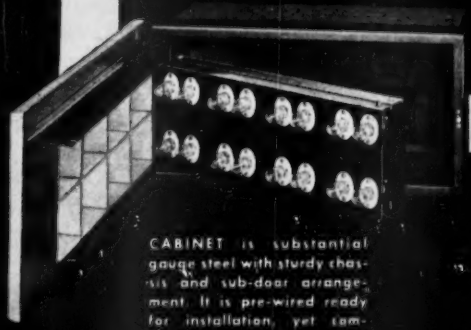

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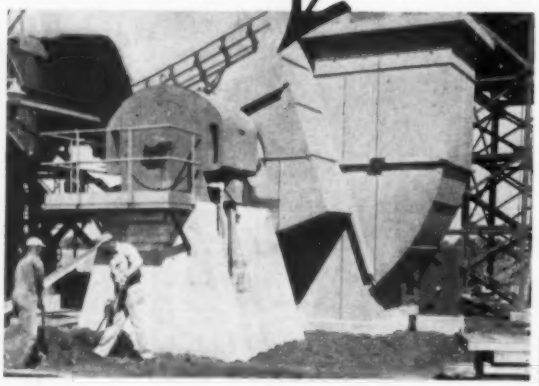

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(*Continued from page 125*)

indicators and points out limitations. Emphasis is made on the proper indicator and its correct application in improving performance of reciprocating engines and compressors.

The booklet also shows how to analyze indicator cards and suggests how this data can be used for balancing engine cylinders and calculating mean effective pressure. Procedures for avoiding mechanical inaccuracy in the setup of indicators are included.

American Power Conference to Meet March 25-27 at Chicago

THE AMERICAN POWER CONFERENCE (formerly Midwest Power Conference) will hold its second annual meeting at Hotel Sherman, Chicago, Ill. on March 25, 26 and 27.

An opening meeting at 10:00 a.m. on Wednesday, March 25, will hear addresses of welcome and a principal address by a top government official, probably Douglas McKay, Secretary of the Interior. This will be followed by the Conference Luncheon at 12:15 p.m.

Technical sessions will begin Wednesday afternoon. Principal subjects to be covered during the three-day session, are:

WEDNESDAY, MARCH 25, 1953

2:00 PM Large Steam Generators
- (a) 3,000,000 Kw Operating Experience with Modern Reheat — Otto de Lorenzi
- (b) Trends Indicating Possibilities in Future Boiler Designs — George W. Kessler

2:00 PM Symposium on Water Problems of American Industry
- (a) Panel Discussion on Water Resources of America — Joseph McCabe, L. N. Rowley and B. G. A. Skrotzki
- (b) Waste Disposal and Stream Pollution from the Point of View of Industry — Harry W. Gehm
- (c) Problems of Waste Disposal and Stream Pollution from the Point of View of the Public — Edward J. Cleary

2:00 PM Problems of Fuel Conversion
- (a) Conversion from Coal to Fuel Oil — George A. Pardee
- (b) Conversion from Coal to Gas — James Brower

3:30 PM Incentive in Personnel Training
- (a) Creating Enthusiasm in Personnel Training — John E. Conway
- (b) Suggested Improvements in Training Methods — C. H. Morrow
- (c) Available Training Programs — A. H. Nielsen

3:30 PM Steam Generator Controls
- (a) Some Control Circuits for Use of Multiple Fuel Firing on Boilers — H. Ziebolz
- (b) Trends in Combustion and Steam Temperature Control — Paul S. Dickey

3:30 PM Electrical Distribution

(a) Double Contingency Outages in Secondary Network Systems — N. M. Neagle and D. R. Nelson
(b) Overhead Primary and Secondary Distribution Networks — H. G. Barnett and D. F. Shankle

3:30 PM Personnel Training — Crystal Room

7:00–10:00 PM Forum — The Industrial Use of Atomic Energy

(a) The Atomic Energy Commissions Appraisal — Gordon E. Dean
(b) Engineering and Technical Problems — Walter Zinn
(c) Economic Evaluation — Walker L. Cisler
(d) Changes in the Atomic Energy Act — Oscar M. Ruebhausen
(e) Current Legislation
(f) Summary — Murray Joslin

THURSDAY, MARCH 26, 1953

9:00 AM–12:00 noon Symposium on Large Steam Turbines

(a) Development of the 3600 rpm Turbine — Homer R. Reese
(b) Factors Influencing the Design and Application of Large Steam Turbines — Carl Schabtach
(c) Cross-Compound Steam Turbines for Large Capacity Installations — Charles D. Wilson

9:00 AM Planning and Economic Analysis

(a) A Technique of System Economic Analysis Useful in Long Range Planning — H. E. Campbell and E. H. Reilly, Jr.
(b) A New Method of Area Wide Generation Control for Interconnected Power Systems — N. Cohn

9:00 AM Hydroelectric Power I

(a) Falcon Dam and Power Plants — J. B. White
(b) The Guayabo Hydroelectric Power Development — E. Montford Fucik

9:00 AM Water Resources and Water Treatment for Small Plants

(a) An Evaluation of our Water Resources — Arthur M. Buswell
(b) Alkalinity Reduction by an Approved Process of Anion Exchange — A. E. Kittredge

10:30 AM Industrial Power (Electrical)

(a) Voltage Flicker from Loads on Electrical Systems — Marvin Fisher, Jr.
(b) Arc Furnaces — Light Flicker and Supply Systems — D. F. Shankle

10:30 AM Hydroelectric Power II

(a) Generation and Use of Niagara and St. Lawrence Power in the Province of Ontario — Richard L. Hearn
(b) The American Development of Power on the Niagara River — Harold I. Howell

10:30 AM Heat Pump Research and Applications

(a) Operation and Performance of New University of Kentucky Earth Heat Pump — E. B. Penrod
(b) The Design and Manufacture of the Heat Pump Water Heater — T. A. Hogdon

12:15 PM American Power Conference Luncheon — Speaker: — B. L. England

2:00 PM Symposium on Large Electrical Generators

(a) Desirable Characteristics for Large Generators — J. B. McClure and C. E. Kilbourne
(b) Inner-Cooling of Turbine Generators
(c) Supercharged Cooling for Large Turbines (speaker to be announced)
(d) Operating Experience with Large Generating Units — Robert P. Liversidge

2:00 PM Fuels and Combustion

(a) Preparation and Combustion of Jet-Pulverized Coal — C. G. Von Fredersdorff
(b) Burning of Paper Mill Waste Liquor — John E. Hoest

2:00 PM Heating of Modern Homes

(a) Recent Advances in the Art of Heating Homes — Robert W. Roose
(b) Load Limiting Controls for Electric House Heating — W. F. Friend

2:00–5:00 PM Symposium on Industrial and Institutional Plant Operation

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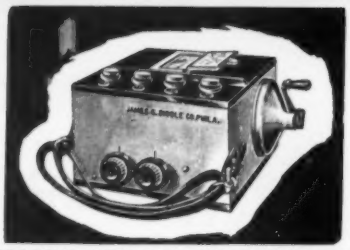

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(a) Problems of a Paper Mill Plant — Wyle Austin
(b) Problems of a Coke Plant — Jack McBrinde
(c) Problems of a Penal Institution Plant — Sal Gran
(d) Problems of a Packing House Plant — Lowell E. Joslin
(e) Problems of a State Hospital Plant — Charles R. Bender

3:30 PM Solid and Liquid Fuels

(a) Long Range Outlook for Liquid Fuels in America — Eugene Ayres
(b) Use of Low Rank Fuels in the United States — Louis C. McCabe

3:30 PM Control of Iron Pickup by Boiler Feedwater

(a) Use of Amines for Control of Iron Pickup — H. J. Guillory
(b) Prevention of Metal Losses in the Wet Steam Areas of Steam Turbines — Francis L. Archibald

6:45 PM ALL ENGINEERS DINNER

FRIDAY, MARCH 27, 1953

9:00 AM Residential Air Conditioning

(a) Promoting the Installation of Residential Heat Pumps — George S. Whitlow
(b) New Application Techniques Improve Residential Air Conditioning — E. P. Palmatier

9:00 AM General Interest Session

(a) Are Federal Power Practices Sound National Policy? — E. Robert de Luccia
(b) The Materials Situation as Related to the Power Industry — J. F. Moore

9:00 AM Characteristics of Ion Exchange Resins

(a) Acid Regeneration of Cation Exchangers — F. A. Lindsay
(b) Factors Influencing the Operation of Anion Exchange Resins — Francis X. McGarvey and J. Thompson
(c) Characteristics of Mixed Bod and Two-Step Ion Exchangers — M. E. Gilwood and C. Calmon

9:00 AM Diesel Engines

10:30 AM Residential and Commercial Heat Pumps

(a) The Air to Air Residential Heat Pump — Gerald L. Biehn
(b) Commercial Year-Round Air Conditioning with the Heat Pump — Philip Sporn

10:30 AM Electronics Applications

(a) Use of Carrier Spectrum — T. A. Cramer
(b) Survey of Power Plant Electronics and Resulting Maintenance — Harold Garton

10:30 AM Gas Turbine Combustion Problems

(a) Combustion in Gas Turbines — Herbert R. Hazard
(b) Corrosion Aspects of Bunker 'C' Combustion in Gas Turbines — B. O. Buckland

12:15 PM American Power Conference Luncheon — Speaker: — E. B. Newill

2:00–5:00 PM Symposium on Gas Turbines

(a) A Regenerative Gas Turbine Generator for Central Station Service — H. C. Davis and B. O. Buckland
(b) Development and Application of Gas Turbines for the Oil and Gas Industry — T. P. Latimer
(c) Jet Aircraft Engines — Dimitrius Gerdan

2:00–5:00 PM Economics of Evaporation and Demineralization — New Mezzanine Room

(a) Economics, the Key to Evaporation vs Demineralization for Makeup in High Pressure Steam Power Plants — E. B. Morris and C. E. Bruno
(b) Evaporation for Treatment of Makeup — A. M. Impagliazzo
(c) Performance of a Complete Demineralization Process for High Pressure Boiler Makeup Water — A. B. Sisson

2:00–5:00 PM Symposium on Network Analysers —

Glen W. Bills — Warren B. Boast — Ralph D. Goodrich — Lewis M. Haupt — James B. Ward — George P. Wilson

HELPFUL BULLETINS

(*Continued from page 36*)

125 Magnetic Air Circuit Breaker — Design and construction features of the Ruptair magnetic air circuit breaker for installation in vertical lift switchgear rated 4.16 kv are described in Bulletin 18B6346B. It diagrams way in which breaker interrupts short circuit current and describes purpose of the arc chute and integrated contacts. Includes ratings, dimensions. Allis-Chalmers Mfg. Co.

126 Power Conversion Units — Illustrated Bulletin GEA-5658A, 8 pp, contains design features, performance, circuits, applications and advantages of a line of metallic rectifier power conversion units. A chart of dimensions, ratings and weights is included. General Electric Co.

127 Junction Boxes — Twelve-pp Bulletin Supplement 130-B covers more than 500 cast iron junction boxes for almost every application. Photos, sectional drawings and specification tables giving dimensions, price and weights of both surface and flush mounted types are provided. O. Z. Electrical Mfg. Co., Inc.

128 Instrument Transformer Buyer's Guide — Publication GEA-4626F is the 1953 edition of company's book on instrument transformers and contains basic, up-to-date information on the complete line. The well-illustrated 102-pp guide provides ratings, ASA accuracy classifications, and prices of indoor and outdoor potential and current transformers. Listings of ratio and phase-angle tests, together with tables covering the mechanical and thermal limits of current transformers are included. General Electric Co.

129 Flexible Cords — This well-illustrated 24-pp booklet includes all of the new Underwriters' classifications for flexible cords manufactured by this company. Featuring data on Dynaprene and rubber jacketed cords as well as braid covered types, also gives information on cord selection, how to order specialties. Whitney Blake Co.

130 Electrical Tapes — This 12-pp illustrated booklet on electrical tapes and related electrical products for construction and maintenance discusses use of company's plastic electrical tapes in wiring, appliance repair, underground cable splicing and other heavy duty applications. Tells how a glass cloth electrical tape with thermosetting adhesive is used where high temperatures are involved. Describes electrical spring connectors for splicing, an electrical insulation putty. Minnesota Mining and Mfg. Co.

DUST COLLECTION

132 Central Vacuum Cleaning System — In 20-pp Bulletin D-5 diagrams and photos show company's Exidust central vacuum cleaning system, designed to pick up dirt and dust by flexible hose and attachments and pass them through a stationary piping system to collector separator tank or tanks. Tells uses of the system, names representative users, and gives design features. Lamson Corp.

133 Dust Collection Equipment — A paper on "Operation, Application and Effectiveness of Dust Collection Equipment", originally presented as part of an industrial ventilation course, is available. Contains charts on costs of dust collecting equipment; range of particle sizes, concentrations and collector performances; drawings of types of dust collectors; list of practical "don't's", and other data on selection, installation and operation of the equipment. American Air Filter Co., Inc.

OTHER EQUIPMENT

134 Soot Blowers on the Job — Bulletin 1004, 32 pp, discusses 15 central station installations of Vulcan automatic-sequential soot blower systems. Power and reheat boilers with capacities to 1,370,000 lb per hour, pressures to 1925 psi and temperatures to 1055 F are included. Blowing medium is steam or air, and units described are power-driven by air or by electric motor. Copes-Vulcan Div., Continental Foundry & Machine Co.

135 High Temp Lubrication — How "dag" colloidal graphite has been used successfully in various lubricating applications involving temperatures up to and over 2000 F is described in Bulletin 423. Acheson Colloids Co.

136 Pliers and Wrenches — Catalog 66 is a 24-pp ordering book on hand tools. Fully illustrated, covers adjustable wrenches and a wide variety of pliers. Includes price list. Utica Drop Forge and Tool Corp.

137 New Job for Ion Exchange — To help explain one of the newer industrial roles of ion exchange, 28-pp Bulletin 3803 titled, "Demineralization including Silica Removal by Ion Exchange," is offered. Due to its economical operating costs, demineralization and silica removal through ion exchange resins has come into extensive use in many phases of industry. Booklet described chief applications; gives operating principles, design features, advantages and specifications of company's apparatus and synthetic resins. The Permutit Co.

138 Equipment For Buildings and Institutions — Bulletin WP-1099-B27M is a 20-pp revised booklet of condensed information on sizes, dimensions, capacities, ratings and features, of a wide range of equipment. Covers air conditioning and refrigeration products, with auxiliaries; oil, gas and dual fuel engines, deaerators and deaerating heaters; water conditionings; steam turbines and turbine generators; liquid meters; centrifugal and other pumps. Worthington Corp.

139 For Problem Coal Handling — Vibrating conveyors designed to operate at natural frequency of their springs are described in two new bulletins. Company says that, in addition to foundry and other applications, these conveyors are suited to carrying coal. And although seldom installed in power plants — less expensive equipment is generally suitable for coal handling — in instances in which screw conveyors don't meet requirements or belt conveyors have high spillage and carryover, the use of these conveyors is said to be justified. Carrier Conveyor Corp.

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FUEL BURNERS

201 Gas Burners — Illustrated Bulletin 410-8, 16 pp, furnishes descriptive and technical data on company's gas burners and combination gas and oil burners, giving design details and explaining operation of each. Coppus Engineering Corp.

202 Oil Burning Equipment — Bulletin O-B, 37 contains 16 pp of technical information on company's oil and gas burning equipment, steam atomizing burners, mechanical atomizing burners, interchangeable burners, telling best applications, including capacity data. Also shows fuel oil pumping, heating systems. The Engineer Co.

203 Steam Atomizing Oil Burners — Sixteen-pp illustrated Bulletin 21 describes steam atomizing oil burners and auxiliary equipment for use with heavy oil or tar in boilers, stills, dryers and other furnaces, where steam or compressed air is available for atomizing the oil. Discusses steam and oil control valves. National Airoil Burner Co., Inc.

BOILERS, GENERATORS

204 Improved Steam Generator — Bulletin 2000, 28 pp, explains advance design features that distinguish this manufacturer's generator from other unit steam generators. Describes and illustrates engineering differences of component features. Also shows how these components are constructed, assembled and tested. Another section gives data, and dimensions and standard and accessory equipment for the units which range from 20 to 6000 hp, for pressures to 250 psi. Preferred Utilities Mfg. Corp.

205 Shop-Assembled Boiler — Sixteen-pp Bulletin G-76, completely describes and illustrates company's Type FM water-tube integral-furnace boiler, made in standard sizes from 2900 to 28,000 lb of steam per hr, pressure to 250 psi. Savings in erection, installation and moving costs are stressed. Capacities, dimensions and weights given. The Babcock & Wilcox Co.

206 Re-circulation Steam Generator — Here's a 6-pp folder on a controlled re-circulation steam generator, describing its development and uses, such as applications where steam is required in remote locations, where demands are intermittent, or load fluctuating. Combustion Engineering-Superheater, Inc.

207 Steam Generators — Twenty-pp Bulletin SB43, 20 pp, describes company's VL factory assembled generators combining 2-drum water-tube boiler, integral water cooled furnace, brick work, insulation and steel casing. A large cutaway illustration shows design details, and gas travel. Use of generator with various fuels and firing arrangements is covered. Erie City Iron Works.

208 Steam Boilers — Form SG 128-749 is a 12 pp catalog illustrated with photos of steam boilers for processing and heating, ranging from 15 to 500 hp and 15 to 200 psi. Includes diagrammatic cross-section of four-pass design characteristic of manufacturer's boilers. Cleaver-Brooks Co.

209 Data on Boilers — Literature is available on boilers from 6 to 250 hp, for coal, gas, or oil firing and all convertible to any other fuel. Explains how, although competitively priced, these boilers are built for long service. The James Leffel & Co.

FUEL OILS, LUBRICANTS

210 Cooperative Technical Consultation Service — This informative 24-pp booklet presents company's periodic consultation service aimed at the most efficient use of petroleum products. Covers services available in the solution of lubrication problems, metalworking operations, processing, fuel oils, dust control. Gulf Oil Corp., Gulf Refining Co.

211 Air Compressor Lubrication Manual — Valuable information on air compressor maintenance is contained in this 40-pp book. Subjects treated include compressed air, compressors and related equipment, lubricating systems, compressor oils and applications, lubrication requirements, operating hints, oil requirements, storage and care of compressor oils, safety precautions. Cities Service Petroleum, Inc.

212 Lubrication of Diesel Engines — An excellent instruction manual, 50-pp Technical Bulletin B-1 (revised) also provides a brief history on diesel engines, an explanation of the fundamentals of design and the common types of diesels and their advantages. Explains combustion process, discusses modern fuel injection systems. Cylinder and bearing lubrication are treated and recommendations given for lubricating oils. Sun Oil Co.

213 Diesels, Their Fuels and Lubricants — This 46-pp book gives practical information on diesel engines, covering their history and economics as well as design characteristics and operating principles. Classification of diesels according to their speed is also explained. Sinclair Refining Co.

214 Versatile Industrial Oil — Described in 20-pp Form AD 4078 is an all-purpose oil offering protection for a wide range of industrial equipment, and available in 15 viscosity grades. Discusses six major characteristics of the oil; explains and pictures its use in hydraulic systems, speed reducers, air compressors, electric motors, hydraulic turbines, bearing sys-

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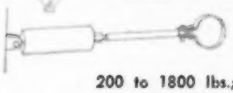

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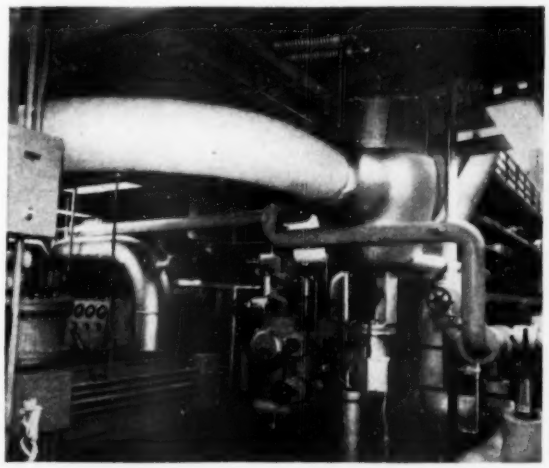

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tems, etc. A chart shows grades available, their uses and physical properties. Standard Oil Co. (Ind.)

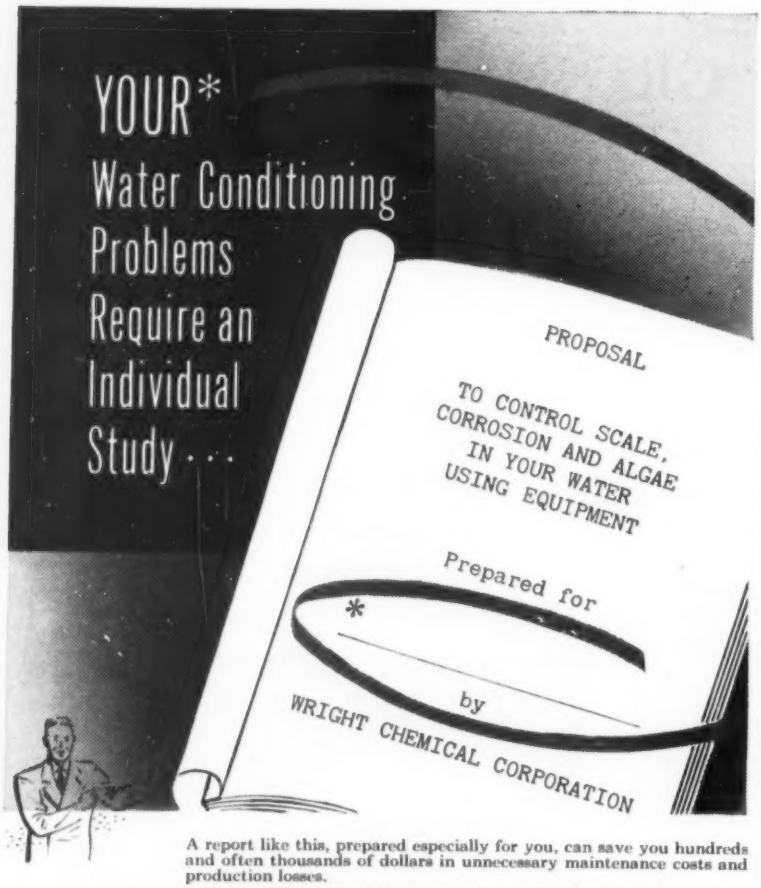
215 Turbine Lubrication — The special problems of turbine lubrication are discussed in 8-pp Bulletin TU-1. Tells how purifiers keep power units in service; discusses inhibited and uninhibited oils, company's process for reducing sludge formation within lubrication system. Illustrated with diagrams of typical installations, photos of purifiers. DeLaval Separator Co.

COAL, ASH HANDLING

216 Where Refuse Is Fuel — Presented in 24-pp Bulletin are installations of company's stokers with medium-size and larger units burning refuse fuels, separately or in combination with coal. Lists many of the refuse fuels handled successfully by this type of spreader stoker. Detroit Stoker Co.

217 Coal Scale — Bulletin 0250, 12 pp, describes a pressure-tight, automatic coal scale, its construction and operation. Shows how beam system, electrical components and linkages are protected from exposure to coal dust. Richardson Scale Co.

218 Economic Coal Storage — How tractors establish safe, orderly coal handling is told in this 8-pp booklet. Stresses flexibility, low operating costs. Also shows how tractors speed storage reclamation and how a tractor-scraper combination offers plus benefits. Illustrated with action photos; picture several models. Tractor Div., Allis-Chalmers Mfg. Co.



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219 Why Liquid Diffusion — What liquid diffusion can do for power plants is explained in Form B, which tells how liquid diffusion compounds work and gives four practical applications. These include dust control in coal handling, fly ash control, coal storage pile treatment and boiler cleaning. Johnson-March.

220 Spreader Stoker Data — This is a file of three illustrated bulletins on spreader stokers. The first discusses seven reasons for selecting these stokers and describes their design, construction and operation; the second, dumping grates, the third, installations. Riley Stoker Corp.

221 Spreader Stoker Selection — Fourteen-pp Form F-520-A10M is intended to help those choosing a spreader stoker to get the most for their investment, and it points out many factors to be considered. American Engineering Co.

TUBING AND ACCESSORIES

222 Condenser Tubes — Excellent information on condenser tubes and their service life is given in this 40-pp illustrated booklet. Subjects discussed include corrosion of condenser and heat exchanger tubes, corrosion resistance and control, the selection of tube materials, and the composition and physical properties of company's alloys. Details on proper installation are presented, as are specifications, conversion tables, weights of tubes and alloys. Scovill Mfg. Co.

223 Life Extension for Condenser Tubes — This 32-pp extensively illustrated booklet reports on research into the causes of corrosion and means of combating them, as well as the choice of condenser tube materials. Points out that Admiralty metal, long a standard for power plant condenser tubes, works satisfactorily in most installations, but other alloys may be necessary in some circumstances. Revere Copper and Brass, Inc.

224 Nickel Pipe and Tubes — Bulletin T-17 is a 27-pp technical bulletin on the fabrication and design of nickel and high nickel alloy pipe and tubing, illustrated throughout by drawings and photos. Presents tables on mechanical and physical properties, ASME code requirements, recommended welding procedures. The International Nickel Co., Inc.

225 Double-Walled Tubing — Technical Bulletin 1950, 12 pp, presents tubing designed for conditions where single-walled tube can't withstand simultaneous attack from two types of corrosive media. Describes and illustrates construction, illustrating possible metal combinations. Explains tubing's use in ammonia refrigeration, boilers, steam generators. Discusses heat transfer properties, high temperature use. Bridgeport Brass Co.

226 Tube Cleaners — Catalog 76-A provides 48-pp of information on manufacturer's line of tube cleaners. Following equipment selection and operating hints, this practical catalog describes and pictures cutter heads and drill heads, brushes, and motors, giving sizes, application information. Electrically driven equipment, air valves, hose, lubricators presented. Thomas C. Wilson, Inc.

227 Rotary Tube Cleaners — Bulletin R-105 presents air and water driven rotary tube cleaners and cleaner accessories. Illustrates several models and heads,

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discussing special features. Roto Div., Elliott Co.

WATER CONDITIONING

228 Water Conditioning Data Book — Recently revised, this pocket-size 116-pp booklet presents a compilation of 77 tables, all valuable to the power engineer. Covers such subjects as hydraulics, impurities in water, boiler feed-water make-up requirements, chemical conversions and chemical reactions. Contains excellent reference information on many phases and methods of water treatment. Available without charge to qualified power engineers. The Permutit Co.

229 What's What on Ion Exchangers — Here are three booklets on ion exchangers: Nalcite HCR, a styrene type cation exchanger; Nalcite SAR, a strongly basic anion exchanger; and Super Nelcolite, a synthetic gel type zeolite for cation exchange. Tables and graphs explain performance of these water treating resins under various operating conditions. Physical characteristics, exchange capacities, regeneration techniques discussed. Bulletin 57, 20 pp, is on Nalcite SAR; Bulletin 58, 28 pp, Nalcite HCR; Bulletin 59, 8 pp, Super Nalcolite. State those wanted. National Aluminate Corp.

230 Modern pH and Chlorine Control — This 100-pp booklet gives details in color comparators and equipment in water testing and control of boiler and industrial process water, also technical information on meaning of pH control, electrometric and colorimetric methods of determining pH and impurities in water; applications of water control in air conditioning; treating boiler feed water. W. A. Taylor & Co.

231 Steam System Treatment — This bulletin on Coravol for prevention of corrosion, explains theory of corrosion, application of organic amines to steam systems (the Coravol process) and presents case histories of use in different types of plants and industries. Coravol is part of a complete technical service providing special chemical formulas for treatment of water, steam, brine, fuel. Western Chemical Co.

232 Corrosion Treatment — "Corrosion Protection of Steam and Condensate Return Systems" is a folder on amine treatment for boiler and condensate systems. This treatment is described as affording surface protection of the metal as well as raising pH value of condensate. The Bird-Archer Co.

233 Treatment by Ion Exchange — Methods of ion exchange treatment and its general and special applications for water and other liquids are explained in 8-pp Bulletin A. Discusses manufacturer's deionizing equipment as to construction and operation, pictures applications. Illinois Water Treatment Co.

234 Boiler Scale — Formation and Prevention — Technical Paper 98 is a 12-pp article covering the cause and prevention of boiler scale. Covers the mechanism of scale formation, effect of boiler scale, chemistry of scale formation, internal chemical treatment and chemical correctives. Diagrams of feeder systems, photos and solubility charts illustrate text. W. H. & L. D. Betz.

235 Boiler Water Manual — Factual information on methods of applying chemicals in treatment of water for boilers is presented in 16-pp Standard Method 122. Discusses pretreatment of raw water, application of chemical feeding to pretreating operations and both constant rate and flow responsive feeding direct to boiler drum and to feed-water system, and condensate returns. % Proportioneers, Inc. %

236 New Data on Zeolite Softeners — Publication 4520-A is a recently revised edition of company's booklet on zeolite water softening. Provides a glossary of terms used in the process, data for laying out a zeolite softening plant, factors governing size of equipment, selection of zeolite materials and discussion of the four stages of operation of a sodium zeolite softener. Cochrane Corp.

237 Water Treatment — Bulletin 5000, 24 pp, explains the reasons for boiler water treatment and tells services offered by company in providing formulations for individual plant requirements. Covers pre-treatment, internal treatment, treatment application, blow-down adjustment, test control. Describes equipment. Dearborn Chemical Co.

238 Feedwater Treatment — Here is a 10-pp illustrated report on boiler feedwater treatment for a high-pressure, high-makeup power and steam producing plant. It is based on studies to determine best method of meeting requirements for both the high-pressure steam used in power generating turbines and the district heating steam for downtown Philadelphia. Graver Water Conditioning Co.

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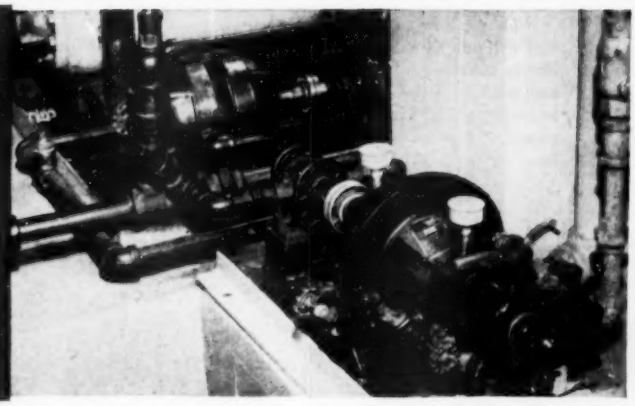

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To insure a continuous flow of heavy fuel oil to the burners, a motor driven SK Gear Pump is used. Another SK motor driven pump and a steam turbine driven SK Gear Pump are utilized as standbys.

The turbine driven unit is especially selected to protect operation in the event of electric power failure.

Highly viscous Bunker "C" Fuel Oil, preheated to 90° to 100° F., is pumped to the main oil heaters and thence to the burners at proper atomizing and burning temperature. WHITMAN'S engineers report that SK Gear Pumps have proved highly satisfactory in their plant because the pumps: (1) operate continuously; (2) pump oil at even pressures; (3) require a minimum of maintenance.

Bulletin 17-A covers, in detail, the wide range of Gear Pumps manufactured by SK. Send for a free copy.

An integral part of the equipment installed in the new and very modern power plant of National Brewing Company, Baltimore, Md., is the SK Duplex Pumping, Heating, and Straining Unit shown.

The "package" consists of an SK Duplex Suction and a Duplex Pressure Strainer, two SK Fuel Oil Heaters, two SK Gear Pumps, and accessory equipment.

The unit handles 19 gpm of Bunker "C" Fuel Oil at 125 psig. The oil suction temperature is about 90° F., the oil heater outlet temperature is 200° F., and steam pressure averages 125 psig.

SK "Packaged" Units of this type are currently in use throughout the country in municipal and industrial power plants and other oil burning installations.

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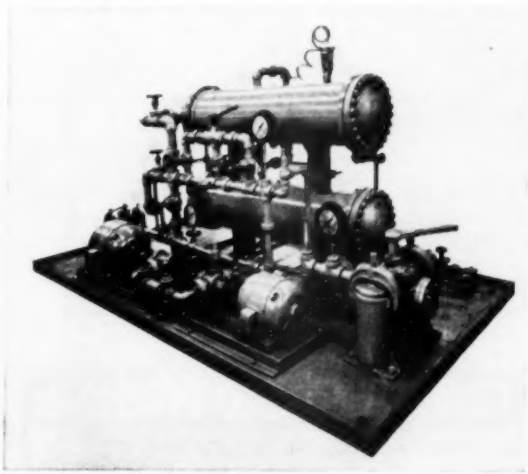

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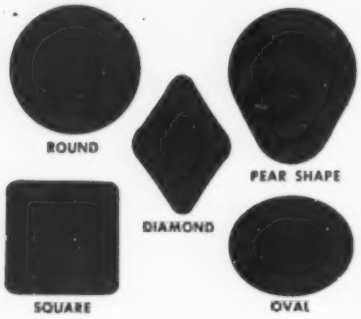

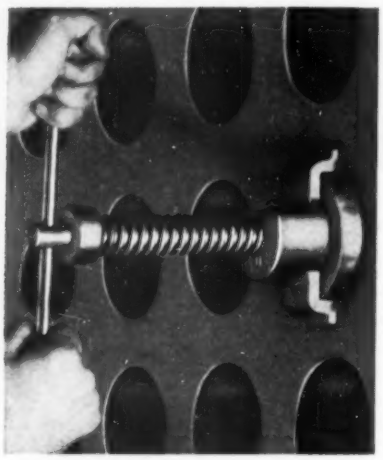

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One man cleaned inside cap seats on boiler header in 4 hours. Formerly took 2 men 3 days.
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239 Microbiological Control — Technical Article 3C, 12 pp, is an illustrated discussion of microbiological control of and through industrial waters. A section on industrial water chlorination covers cooling waters and process waters. Other sections deal with chlorine metering in chemical processes, and the sanitary aspects of industrial water treatment. Wallace & Tiernan.

PUMPS AND COMPRESSORS

240 Centrifugal Pump Handbooks — Two instruction booklets covering the installation, operation and repair of company's single-stage single-suction and multi-stage centrifugal pumps are available. Suggest regular inspection procedures and include pages for maintenance records. Also provide handy tables explaining how to locate trouble and listing causes and cures. Bulletin 08X7813, 24 pp, covers single-stage pumps; Bulletin 08X7780, 48 pp, covers the multi-stage pumps. State choice or both. Allis-Chalmers Mfg. Co.

241 Rotary Pump Service Manual — The installation, operation and maintenance of rotary pumps are covered in 12-pp Service Manual 100-2. Subjects discussed include installing of foundation bolts, alignment, supporting vertical pumps, grouting, piping, suction lines, hot liquid pumps, rotation, packing, dismantling, reassembly, starting, operation and standing idle. Warren Steam Pump Co.

242 Condensed Pump Data — Form 4383-J covers more than 20 types of general service pumps, rotary pumps, sump and drainage pumps, condensate units, self-priming units, stainless steel pumps and high pressure pumps. In easy-to-find tabular form, each model is pictured along with its characteristics, applications, features and references to specific literature providing further information. Goulds Pumps, Inc.

243 Controlled Volume Pumps — Bulletin 351, 16 pp, describes company's air-powered controlled volume pumps, designed to pump practically any liquid in measured volumes accurate to within a fraction of 1 per cent. Pumps are reciprocating, positive displacement plunger types. Cross-sectionals show design and operating details. Controls and typical automatic feed systems are discussed. Milton Roy Co.

244 Boiler Feed Pump — A barrel-type boiler feed pump for high pressure, high temperature service and designed to go on the line quickly without preliminary warm-up, is the subject of 12-pp Bulletin 1525. Fully illustrated text explains automatic operation of hydraulic thrust balance incorporated in this pump. De Laval Steam Turbine Co.

245 For Controlled Volume Pumping — Bulletin 300, 24 pp, describes Pulsafeeder piston-diaphragm pumps, stressing their no-stuffing box feature and noting that although basically a pump, this unit can do the work of a feeder, meter, instrument, filling machine, proportioner and sampler. Process Equipment Div., Lapp Insulator Co., Inc.

246 Compressor Selection Chart — Based on normal applications handling air with atmospheric intake pressure, this chart simplifies selection of proper size compressor, giving quick comparison between discharge pressure pounds per

square inch gage and piston displacement cubic feet per minute. Worthington Corp.

VALVES, TRAPS, PIPING AND ACCESSORIES

247 Safety Valve Engineering Data — How company's safety valve works and its operating advantages are explained in Bulletin 707. Includes dimensions on valve types, tables on superheat correction factor. Manning, Maxwell & Moore, Inc.

248 Popular Steel Valves — Condensed Catalog 104, 28 pp, describes and illustrates most widely used of company's cast and forged steel valves and the data presented for these valves is complete. Those listed are chiefly in the basic steam pressure classes — 150 to 2500 lb — and include globe and angle, gage, instrument, hydraulic and relief types, also strainers and check, gate, non-return and blow-off valves. Edward Valves, Inc.

249 Regulating Valves — Bulletin 313 describes double seated diaphragm regulating valves for use with control instruments, outlining special features of the valves, particularly the "flow line" contoured body engineered to provide for high capacity at low pressure drop. Leslie Co.

250 Check Valves — Twenty-pp Catalog 30 presents company's line of tilting-disc check valves made in iron, bronze and steel for working pressures to 3000 psi. Explains operating principle of tilting disc construction, discusses closing without slam, reduced loss of head, other advantages. Includes construction details, sizes. The Chapman Valve Mfg. Co.

251 Valve Specialties — Included in 90-pp Catalog A-50 is ordering and engineering information on automatic pressure flow and liquid level controls for steam, air, gas, water, oil, other fluids. Sections are devoted to pressure regulators, altitude valve, pump governors and strainers; lever, float and motor operated valves; pilot valves; back pressure, relief and non-return valves, steam trap and air vent; liquid level controllers; solenoid valves. Davis Regulator Co.

252 For Quick Valve Selection — Here's a 20-pp catalog digest providing ordering and application information on gate, globe, angle and check valves in bronze, iron, cast and forged steel construction, also valve accessories and parts. Illustrated and thumb indexed, includes pressure-temperature chart. The Ohio Injector Co.

253 General Service Valves — Bulletin E-160, 16 pp, describes and illustrates design and construction of company's quick-operating valves, explaining their application to blow-off service and on chemical process, soot blowers, water column blow-down, and other types of pipe line. Everlasting Valve Co.

254 Solving Steam Trap Problems — This 36-pp catalog on steam traps contains specifications and capacities on steam traps, float traps, air release valves and pipe line strainers. Tells how to calculate condensation loads and select traps for all classes of equipment, including unit heaters, jacketed kettles, autoclaves, submerged surfaces, steam mains and header drips. Gives pointers on how to install and service traps. The V. D. Anderson Co.

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Again demonstrating their remarkable effectiveness as a low-cost temperature control, a large processor reports Nicholson expansion steam traps, at about $35 each, are being installed on outdoor tanks and stills in place of temperature controls. These were costing $110.00 to $200.00, with cost of trap added.

The Nicholson traps are readily adjusted to pass condensate at any temperature below 212°F. Easily installed, usually without supports. Pressures, 0 to 250 lbs.

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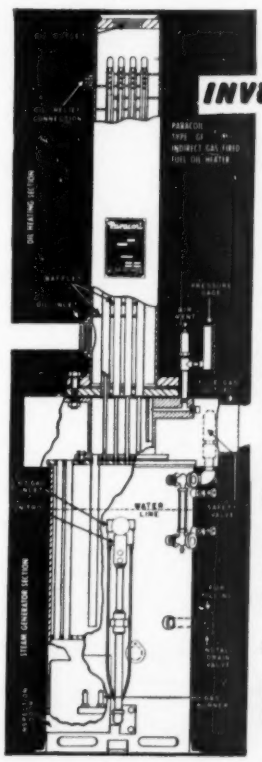

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ONE HEATER CAN SERVE MANY BURNERS!

No steam piping required. Heater operates on a closed, internal steam and condensate cycle!

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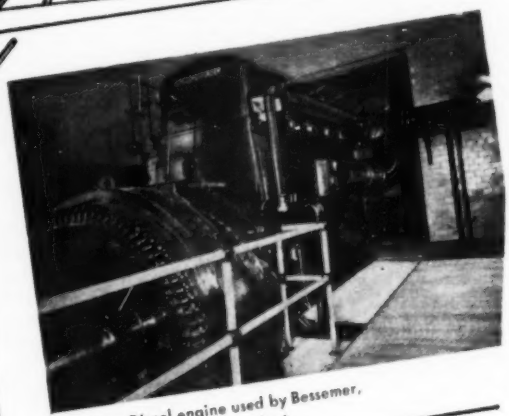

Nordberg Diesel engine used by Bessemer, Michigan Municipal Power Plant.

PISTONS PULLED AT 24,600 HOURS!

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Rings should last at least 10,000 more hours

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OIL CHANGE AT 5000 HOURS!

- No oil added to crankcase between changes
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255 Steam Trap Book — Catalog J, 44 pp, serves as a manual of trapping practice. Includes a catalog section giving physical data and prices on cast semi-steel and forged steel inverted bucket steam traps, compound steam traps and ball float air and air relief traps; a handbook section explaining how to calculate condensate loads and select traps for all classes of equipment; a maintenance section explaining trap installation, trouble-shooting and repair. Armstrong Machine Works.

256 Steam Trap Reference Manual — Bulletin T-1740, 24 pp, tells why and where steam traps should be used; explains desirable trap features. Advantages of company's impulse steam traps are described, their operation illustrated. How to figure trap sizes and how to size condensate return lines are told and capacity and pipe dimension charts and thermodynamic properties of saturated steam included. Yarnall-Waring Co.

257 Steam, Air and Gasoline Traps — Illustrated Catalog 751, 32 pp, provides capacity tables, installation diagrams and a section containing data, charts and formulas for determining proper size trap for specific applications. Covers thermostatic steam traps for pressures to 225 lb, expansion steam traps, weight-operated traps for steam, air and gasoline as well as piston-operated steam traps. W. H. Nicholson & Co.

258 Piping Pointers — This is company's highly popular 36-pp manual covering fundamentals of sound piping practices. Discusses various types of valve designs and how each should be used. Pictures and names more than 80 fittings and contains illustrated how-to-do-it features. Includes 8 pp valve selection guide. Crane Co.

259 Unions and Fittings — Twelve-pp Catalog 50 covers manufacturer's line of unions of all types, elbows, tees and fittings. It describes and illustrates special features. Dart Union Co.

260 Flanges for Severe Service — This 4-pp bulletin describes a flange specially developed for services involving severe abrasion and corrosives, and for suction and discharge service. Goodall Rubber Co.

261 Handbook on Fittings, Flanges — Catalog wf-1950, 68 pp, offers working information on seamless carbon steel welding fittings and forged steel flanges. Includes dimensional tolerances, thread standards and threading practice; service pressure ratings, physical and chemical requirements. Grinnell Co., Inc.

262 Forged Fittings — Literature is available on screw-end and socket-weld fittings. Stresses economy and other advantages of these fittings, lists steels available. Watson-Stillman.

263 Duplex Strainer — This literature describes company's Duplex strainer with single handwheel control. Shows how it is designed with only one stuffing box and can be cleaned under full flow. R. S. Products Corp.

ELECTRICAL

264 Electrical Maintenance Tips — Booklet B-5477, 28 pp, gives a complete outline of preventive electrical maintenance. Discusses general maintenance pro-

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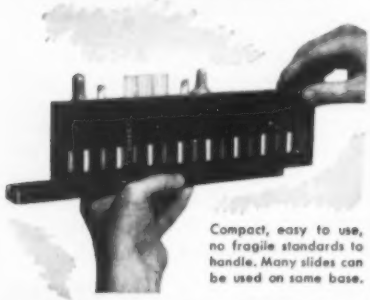

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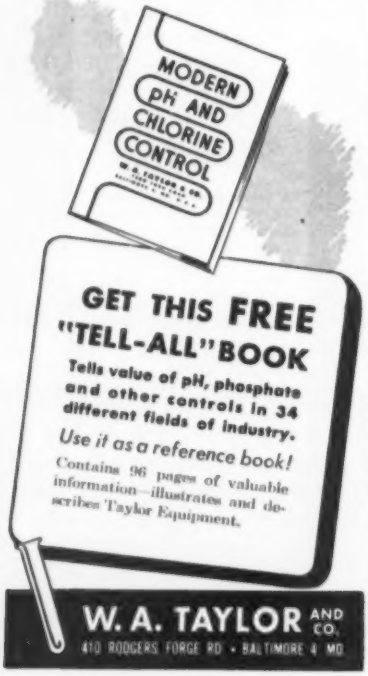
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grams designed to reduce shutdown time and treats in detail the maintenance of power equipment. A suggested schedule of work and cleaning on power equipment is presented in chart form. Essential information on preventive maintenance for turbines, generators, switchboards, motors, controls is provided. Westinghouse Electric Corp.

265 Wire, Cable Ordering Guide — Newly-released General Catalog W-52-3, 186 pp, presents more than 500 different types of wires and cables. Contains comprehensive data on construction and operating characteristics for control and signal cables, cables for construction work, telephone wire and cables, and portable cords. A detailed technical engineering data section is included. United States Rubber Co.

266 Watthour Meter Selection Tips — This 52-pp pocketsize guide gives information needed to select and install any of company's watthour meters. The bulletin, GET-2376, explains uses of the meters while pointing out basic considerations pertinent to selection. Illustrations and circuit diagrams included. In addition, instrument transformers and demand devices are discussed for energy and power measurement. General Electric Co.

INSTRUMENTS AND CONTROLS

267 Supervisory Instruments — Catalog 90-2, "Supervisory Instruments for Power Generation," consists of 41 pp on the instrumentation involved in generating stations. Separate sections cover steam generation instrumentation, turbine and generator instrumentation, electrical distribution instrumentation and diesel engine instrumentation. Measurement of temperature, pressure, flow, power generation and other variables discussed. Brown Instruments Div., Minneapolis-Honeywell Regulator Co.

268 For Practical Men — This 24-pp pocket-size booklet presents insulation testing in simple language. Packed with maintenance hints, explains electrical insulation, tells how it can be tested and what makes it go bad. It describes the Megger insulation tester and justifies its cost in long run economy. James G. Biddle Co.

Postage-free cards for ordering catalogs and bulletins are provided on pages 36 and 130

269 Industrial Thermometers — Catalog 125, 28 pp, presents ordering data on a wide range of industrial thermometers, giving scale ranges, dimensions and prices. Features company's Adjust-Angle thermometer designed for use at any angle front to back, left or right, through a 180 deg arc. Gives construction details and advantages of this adjustable-stem type instrument. Weksler Thermometer Corp.

270 Steam Calorimeter — Bulletin 118 discusses an improved U-path calorimeter combining a throttling, separating and re-evaporating calorimeter in a single chamber. Explains construction and operation of the unit. Ellison Draft Gage Co., Inc.

271 Easy Reading Gage — An all-hydrostatic remote reading gage for boiler water and other liquid levels is described in Catalog 500, Section CO. Pictures improved visibility, other advantages offered by this gage, explains operation. The Reliance Gauge Column Co.

272 Sight Glass Flow Indicators — Twelve-pp Bulletin 18-W, on company's line of flow indicators, shows how these mechanical devices indicate fluid flow and its direction in pipelines which can be directly observed through a sight glass and are suitable for service with liquid, gas, vapor, slurry or sludge sufficiently translucent to permit observation of indicating element. Schutte and Koerting Co.

273 Oxygen Analyzers, Recorders — Bulletin 105, 6 pp, describes and pictures oxygen analyzers and recorders giving their general characteristics, and features, explaining their paramagnetic principle of operation, and discussing their applications. Covers both deflection and null type analyzers. Also discusses sampling requirements. Arnold O. Beckman, Inc.

274 Pressure Regulator — Bulletin 1-B, 8-pp discusses design, operation and applications of a super-sensitive pressure

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regulator; shows typical installations. Also covers a compound regulator for controlling back pressure relief valve. Atlas Valve Co.

276 Gage Cocks — Quick-opening and self closing gage cocks in models designed for pressures up to 250 lb and 450 lb, and a wood wheel gage cock designed for pressures up to 150 lb are described in this illustrated folder. Explains construction, applications. The Paul B. Huyette Co., Inc.

277 Electronic Control System — Bulletin A-701 introduces company's Autronic system, a miniature all-electronic system for controlling pressure, temperature, flow and level, intended for use in chemical processing plants, refineries, central stations, other applications where fast, accurate control is required. The Swartwout Co.

278 Instruments Control Systems — Twelve-pp Catalog 513 presents manufacturer's line of instruments, control systems, regulating valves and desuperheaters. Covers draft and pressure instruments, boiler meters, recorders, thermometers, regulators, combustion controls, pump controls and many others. Republic Flow Meters Co.

279 Boiler Control — Ten-pp Bulletin 1007 describes a completely integrated system for controlling combustion, feed water, boiler steam temperature and boiler cleaning, available in a single package or furnished separately. Illustrated with full color drawing of complete control, photos of recorders, drive unit. Covers instrumentation with both miniature and standard instruments. Copes-Vulcan Div., Continental Foundry & Machine Co.

280 Panel Planning Ideas — The engineering and economical planning of modern combustion and process control panels is discussed in 8-pp Bulletin 170. Numerous panel designs, fashioned for control, are illustrated along with the most up-to-date methods of tubing and wiring. A section on accessories helps make this a valuable source book of ideas for control station planners. Bailey Meter Co.

281 Control Centers — This 31-pp application booklet (B-5621) on control centers stresses the case for centralizing all controls of an entire system in one group of enclosures. Discusses the characteristics of control centers that make for flexibility of use, ease of servicing, safety. Three types are described, and the various electrical components that make up typical units are illustrated. A three-step building-block system of planning control centers is given. Westinghouse Electric Corp.

HEAT EXCHANGING, COOLING

282 Heat Exchangers — The advantages of film-type heat exchangers in the solution of cooling water problems, even when dirty water must be used, are stressed in Bulletin HE-7, 8 pp. Explains and illustrates design details. Discusses use of these heat exchangers in power plants, chemical plants, and in a compression plant. Henry Vogt Machine Co.

283 Heat Exchanger — Bulletin 114, a small folder, gives concise information on company's Aero heat exchanger with balanced wet bulb control designed to cool engines or process equipment, coolants and lubricants, liquids and gases for processing operations. Niagara Blower Co.

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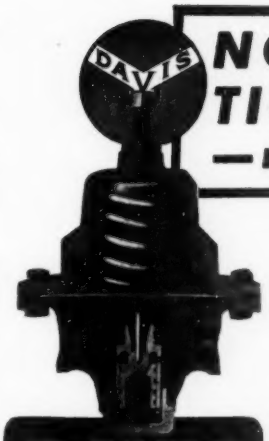

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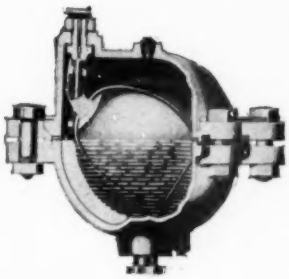

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284 Finned Tube Heat Exchanger — Bulletin 1400, 20 pp, fully describes the company's G-R Twin G-Fin Section heat exchanger. The unit has wide application for heating and cooling liquids and gases, and for condensing vapors, according to the company. Suitable as boiler feedwater preheaters, fuel oil heaters, etc., features of design and construction are given. Specifications and dimensions are included. Griscom-Russell Co.

285 Cooling Towers — Bulletin AQ-50 is on packaged water cooling towers in 3 to 50 t sizes. Gives specifications for the tower and discusses special features. Also provides dimensional and application data. The Marley Co., Inc.

PACKINGS, GASKETS, SEALS

286 Packings and Gaskets — Catalog P-100C, 32 pp, covers 95 most popular packings and gaskets in company's line, furnishing details of construction, service recommendations and size information. Includes charts showing specific recommendations for a wide variety of applications. Packing Div., Raybestos-Manhattan, Inc.

287 Seals for Bearings — Complete information on manufacturer's Klozure oil and grease seals for bearings is available in 100-pp Catalog 10. Fully illustrated in color, pictures all types of these seals, typical applications and lists sizes and part numbers. Also describes mechanical pressure seals for rotary shafts. The Garlock Packing Co.

288 Manual on Packings — Containing 84 pp of engineering and ordering information Catalog 40 covers packings for practically every service. Includes packaging recommendation charts, conversion tables. The Belmont Packing & Rubber Co.

REFRACTORIES, INSULATION

290 Industrial Insulations — Just released, this 20-pp catalog describes insulating materials covering the temperature range from −150 to 1800 F, and including cement, block, blanket, felt and pipe covering. Complete with thermal-conductivity graphs and heat loss charts, catalog also shows list prices. Brief application descriptions included, also typical uses, sizes, packaging, densities. Baldwin-Hill Co.

292 Refractory Cements — Sixteen-pp Form 863, presenting a line of refractory cements, discusses the three basic materials used in them, provides a detailed selection guide and illustrated discussion on methods of preparation and installation. Also defines terminology. Norton Co.

OTHER EQUIPMENT

293 Chemical Cleaning Service — Reduced maintenance costs and outage time are among advantages of company's chemical cleaning service for steam equipment and water lines discussed in this 8-pp bulletin. Before-and-after photos show some actual cleaning jobs and several case histories are given. Company's service procedure and facilities outlined. Dowell Inc.

296 The ABC of CO_2 — An interesting text covering role of carbon dioxide in combustion efficiency, 16-pp illustrated Bulletin 452 discusses theoretical vs practical perfection of combustion and tells how to determine percentage of CO_2 in flue gases. CO_2 as a basis for figuring heat and fuel losses is also described and method of determining such losses explained. The Hays Corp.

298 Turbine Generators — Bulletin H-18, 40 pp, covers turbine-generators of 500 kw and above, pictures nearly 50 turbine-generator installations, both utility and industrial. Brief discussions of generator and exciter cooling methods are included. A reference section offers detailed drawings showing a typical installation arrangement. Elliott Co.

299 Mechanical Draft Fans — Mechanical draft fans for both forced and induced draft service are described in 20-pp Bulletin 168. Illustrated with drawings of typical fan types and photos of installations, includes performance curves showing efficiencies of various types of fans. The Green Fuel Economizer Co., Inc.

300 Dowtherm Vaporizer — Bulletin No. 48-2, describing manufacturer's Type "A" Dowtherm Vaporizer, tells how this unit is designed to evaporate Dowtherm to provide dependable operation at maximum temperatures. The Wickes Boiler Co.

301 Simplified Radiation Heating — Convector radiators designed for connection directly into process steam lines and for operation at pressures up to 150 psi are described in this bulletin. Explains how heat emission rate increases with pressure, and stresses high heat output, good drainage, low surface temperature. Shaw-Perkins Mfg. Co.

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GREEN FUEL ECONOMISER CO. 126
Agency—Sanger-Funnell, Incorporated
GRINNELL CO., INC. 131
Agency—Horton-Noyes Company
GRISCOM-RUSSELL CO., THE *
Agency—Michel-Cather, Inc.
GULF OIL CORP. *
Agency—Young & Rubicam, Inc.

D. W. HAERING & CO., INC. *
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HAGAN CORPORATION *
Agency—Ketchum, Macleod & Grove, Inc.
HALL LABORATORIES, INC. *
Agency—Ketchum, Macleod & Grove, Inc.
HAYS CORPORATION, THE 45
Agency—Proebsting, Taylor, Inc.
PAUL B. HUYETTE CO. 145

ILLINOIS WATER TREATMENT CO. 139
Agency—Howard H. Monk & Associates
INFILCO INCORPORATED *
Agency—Ruthrauff & Ryan, Inc.
INTERNATIONAL NICKEL COMPANY, INC., THE *
Agency—Marschalk & Pratt Co.

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LADISH CO. *
Agency—The Cramer-Krasselt Co.
LAPP INSULATOR CO. *
Agency—Ed. Wolff & Associates
JAMES LEFFEL & CO., THE 109
Agency—Kight Advertising Inc.
LESLIE CO. *
Agency—Mercready, Handy & Van Denburgh

MANNING, MAXWELL & MOORE, INC. 24
Agency—Fuller & Smith & Ross, Inc.
MARLEY COMPANY, INC., THE 101
Agency—Valentine-Radford Advertising
THE MERCOID CORPORATION *
MILTON ROY CO. *
Agency—Harris D. McKinney, Inc.
MINNEAPOLIS-HONEYWELL REG. CO. 96–97
Agency—The Aitkin-Kynett Co.
MUNDET CORK CORP. *
Agency—J. C. Bull, Inc.

NATIONAL AIROIL BURNER COMPANY, INC. *
Agency—R. E. Lovekin Corp.
NATIONAL ALUMINATE CORPORATION 34
Agency—Armstrong Advertising Agency
NATIONAL BUSINESS PAPERS *
NATIONAL VALVE & MFG. CO. 92
NIAGARA BLOWER COMPANY 118
Agency—The Moss-Chase Company
NICHOLSON & CO., W. H. 137
Agency—Wilbur A. Myers
NORTON COMPANY 91
Agency—James Thomas Chirurg Company

OHIO INJECTOR CO. 6
Agency—Fuller & Smith & Ross, Inc.

PACIFIC PUMPS INC. *
Agency—The McCarty Co.
PANALARM PRODUCTS, INC. 125
Agency—Thomas R. Sundheim
PANELLIT INC. *
Agency—Thomas R. Sundheim
PEABODY ENGINEERING 115
Agency—Richard La Fond Advertising Inc.
PERMUTIT CO., THE Back Cover
Agency—Cunningham & Walsh, Inc.
PIPE AND TUBULAR PRODUCTS 100
Agency—The Technigraphic Co.
POWELL CO., THE WM. 142
Agency—Associated Advertising Agency, Inc.
PREFERRED UTILITIES MFG., CORP. 120
Agency—Richard La Fond Advertising, Inc.
%PROPORTIONEERS, INC.% *
Agency—Hammond-Goff Co.

RAYBESTOS—MANHATTAN, INC. 146
Agency—Gray & Rogers
RELIANCE GAUGE COLUMN COMPANY 108
Agency—Carr Liggett Advertising, Inc.
REPUBLIC FLOW METERS CO. 30–31
Agency—Glenn, Jordon, Stoetzel, Inc.
REVERE COPPER AND BRASS, INC. *
Agency—St. Georges & Keyes, Inc.
RICHARDSON SCALE CO. 114
Agency—O. S. Tyson and Company, Inc.
RILEY STOKER CORPORATION 28–29
Agency—The Davis Press, Inc.
ROTO DIV. OF ELLIOTT CO. 136
Agency—Jos. S. Vogel & Co.
R-S PRODUCTS CORPORATION 123
Agency—Carl M. Craig Agency

SCHUTTE & KOERTING 135
Agency—Harris D. McKinney, Inc.
SCOVILL MFG. CO. 133
Agency—Edward W. Robotham & Co.
SHAW PERKINS MFG. CO. 127
Agency—Armstrong Advertising Agency
SHELL OIL COMPANY *
Agency—J. Walter Thompson Co.
SIMPLEX VALVE AND METER CO. 141
Agency—Cunningham & Walsh, Inc.
SINCLAIR REFINING CO. 19
Agency—Morey, Humm & Johnstone, Inc.
STANDARD OIL CO. (INDIANA) 37
Agency—McCann-Erickson, Inc.
STONE & WEBSTER ENGINEERING CORPORATION *
Agency—Harold Cabot & Co., Inc.
STONHARD CO. *
Agency—Philip Klein, Inc.
SUN OIL COMPANY 9
Agency—Gray & Rogers
SWARTWOUT COMPANY, THE 49
Agency—Palm & Patterson
SYNCO CORP. *

TAYLOR & CO., W. A. 140
Agency—Emery-Advertising Corporation
TERRY STEAM TURBINE CO., THE *
Agency—Gassaway, Mark & Co.
TEXAS CO., THE *
Agency—Erwin, Wasey & Company, Inc.
TUBE TURNS, INC. *
Agency—Griswold Eshleman Co.

U. S. ELECTRICAL MOTORS INC. 145
Agency—The McCarty Co.
UNITED STATES RUBBER COMPANY 20
Agency—Fletcher D. Richards, Inc.
UNITED STATES TREASURY *

VACO PRODUCTS CO. *
Agency—Kencliffe, Breslich & Co.
VOGT MACHINE CO., HENRY 47
Agency—Farson & Huff

WALLACE & TIERNAN PRODUCTS, INC. 122
Agency—Branstater Associates, Inc.
WARREN STEAM PUMP CO., INC. *
Agency—The Davis Press, Inc.
WATSON-STILLMAN CO. 121
Agency—McNevin-Wilson-Dalldorf, Inc.
WEKSLER THERMOMETER CORP. *
Agency—Richard & Gunther, Inc.
WESTERN CHEMICAL COMPANY *
Agency—Carter Advertising Agency, Inc.
WESTERN PRECIPITATION CORP. *
Agency—Dozier, Eastman & Co.
WESTINGHOUSE ELECTRIC CORPORATION 26–27, 116
Agency—Fuller & Smith & Ross, Inc.
WHEELER MFG. CO., C. H. 40–41
Agency—The Roland G. E. Ullman Organization, Inc.
WICKES BOILER CO., THE 124
Agency—Price, Hedrick & Tanner, Inc.
JOHN WILEY & SONS, INC. *
Agency—Waterson & Fried, Inc.
WILSON, INC., THOMAS C. *
Agency—Michel-Cather, Inc.
WING MFG. CO., L. J. 112
Agency—Willard H. Myers Advertising Agency
WORTHINGTON CORPORATION 93
Agency—James Thomas Chirurg Company
WRIGHT CHEMICAL CO. 132
Agency—Schnell & Associates

YARNALL-WARING COMPANY 10–11, 52
Agency—The Michener Co.

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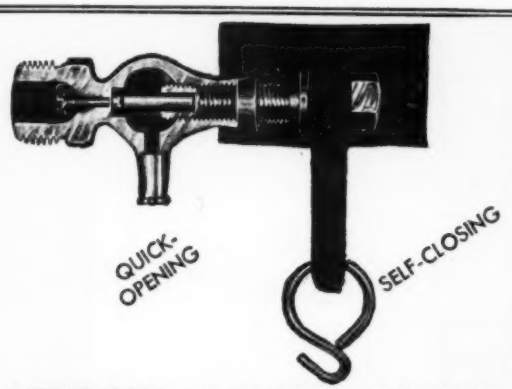
For more data circle 585 on Post Card



"PBH" GAUGE COCK

A gentle pull opens this sturdy, long-wearing gauge cock and an adjustable weight automatically closes it when you let go. Removable monel metal seat and copper valve pencil insures leak-tight service.

Write today for catalogue and prices

The PAUL B. HUYETTE CO., Inc.

401 N. BROAD ST. *EST. 1896* PHILADELPHIA, PA.

WATER GAUGES—Vertical and Inclined
GAUGE-GLASS PROTECTORS • AIRTITE
BOILER WALL COATING • WATER COLUMNS •
BOILER ALARMS, INSTRUMENTS & CONTROLS

U.S. VARIDRIVE

GO MODERN with U. S. Varidrive, the miracle motor that changes to any selected speed, *instantly*. It can run slow, fast or at any speed in between, right to a split rpm. You don't have to change gears, shift belts or use a rheostat. Just turn a control dial. Entire unit is self contained, all on one base.

In countless instances the U. S. Varidrive Motor has paid for itself within a few weeks by stepping up output. Our bulletin tells you why.

2 to 10,000 rpm—¼ to 50 hp

U.S. ELECTRICAL MOTORS Inc.
(Box 2058) Los Angeles 54, California
or Milford, Conn.

US MOTORS

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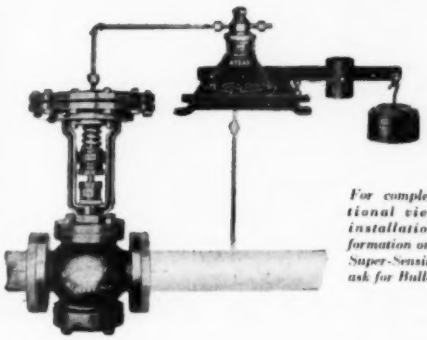
ATLAS

Super-Sensitive

PRESSURE REGULATORS



For complete data, sectional views, typical installations, and information on the ATLAS Super-Sensitive Regulator, ask for Bulletin 1-B.

If you want to maintain pressures within fractions of one pound—and without perceptible variation—specify an ATLAS Super-Sensitive Regulator.

For reduced pressures of 2 to 15 pounds, specify No. 801.
For reduced pressures of 0 to 5 pounds, specify No. 801-8.
For reduced pressures of 15 to 150 pounds, specify No. 802.
We also have Super-Sensitive Pressure Regulators for reduced pressures higher than 150 pounds. Data furnished on application.

Where Applicable?

Excellent for handling steam, water, air, or gas—where it is desired to maintain constant reduced pressure in heating mains, vats, cookers, retorts, etc. Also usable as an altitude regulator where it is desired to maintain a constant level in open tanks, or as a pump governor where a constant delivery pressure is required.

In fact this remarkable regulator accommodates itself to an almost limitless range of applications. It regulates, accurately, between the initial pressure and atmosphere in one stage, operating control valves in all sizes from ½" to 6".

See list of other ATLAS products below

ATLAS VALVE COMPANY
REGULATING VALVES FOR EVERY SERVICE
293 South St. **Newark 5, N. J.**

Represented in Principal Cities

Campbell Boiler Feed Regulator
Temperature Regulators
Reducing Valves
Exhaust Control System
Pressure Regulators
Pump Governors
Damper Regulators
Back Pressure Valves
Balanced Valves
Control Valves
Float Valves

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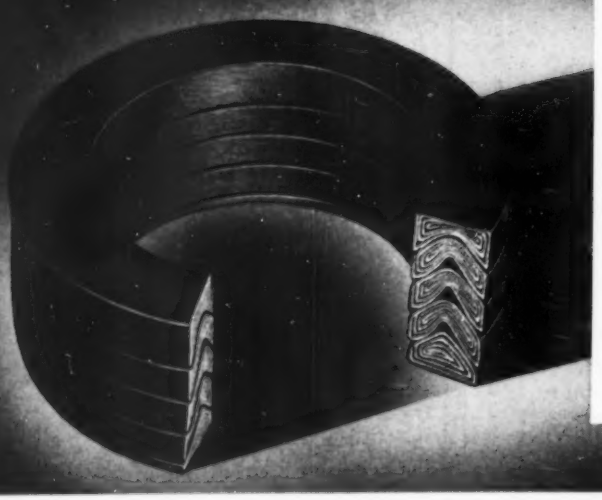
What is your special packing problem?



- [ ] Pressure
- [x] Maintenance
- [ ] Acids
- [ ] Alkalis
- [ ] Complicated inventory
- [ ] Temperature
- [ ] Petroleum products
- [ ] Food products

If it's maintenance . . .

use R/M Vee-Flex® — the packing that provides better sealing with fewer gland adjustments

The unique design of the R/M Vee-Flex Packing Ring provides automatic sealing without constant gland adjustment. The hydraulic principles of this design have been demonstrated by photoelastic stress analyses* and radial pressure tests.*

R/M Vee-Flex Rings are available for all sizes of rods and rams, and for pressures of 6000 psi and higher. Special types are available for use with foods and petroleum products.

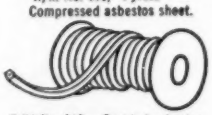
Whatever your packing problem, the authorized R/M distributor near you has a packing engineered to your needs and your budget. Call him today or write us for the R/M Packing Catalog.

R/M is ready to meet your requirements for Teflon Packings, Gaskets, Rods, Sheets, Tubes and Tape.

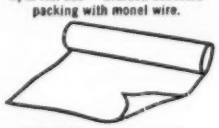
**Performed at the Franklin Institute Laboratories for Research and Development.*

***Du Pont trade-mark for its tetrafluoroethylene resin.*

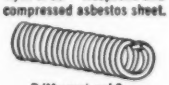
R/M No. 650, "Pyroid"* — Compressed asbestos sheet.



R/M No. 303 — Braided asbestos packing with monel wire.



R/M K-68 — Neoprene and compressed asbestos sheet.



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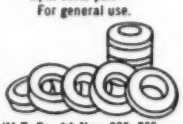

R/M Teflon** Nos. 830, 836 — For acids, caustics or chemicals.

R/M PACKINGS

RAYBESTOS-MANHATTAN, INC.

PACKING DIVISION, MANHEIM, PA.

FACTORIES: Bridgeport Conn., Manheim, Pa. Passaic N.J. No. Charleston, S.C. Crawfordsville, Ind., Canadian Raybestos Co. Ltd., Peterborough, Ontario, Canada

RAYBESTOS-MANHATTAN, INC., Manufacturers of Packings • Brake Linings • Brake Blocks • Clutch Facings • Fan Belts • Radiator Hose • Industrial Rubber Products • Rubber Covered Equipment • Asbestos Textiles • Teflon Products • Sintered Metal Products • Abrasive and Diamond Wheels • Bowling Balls

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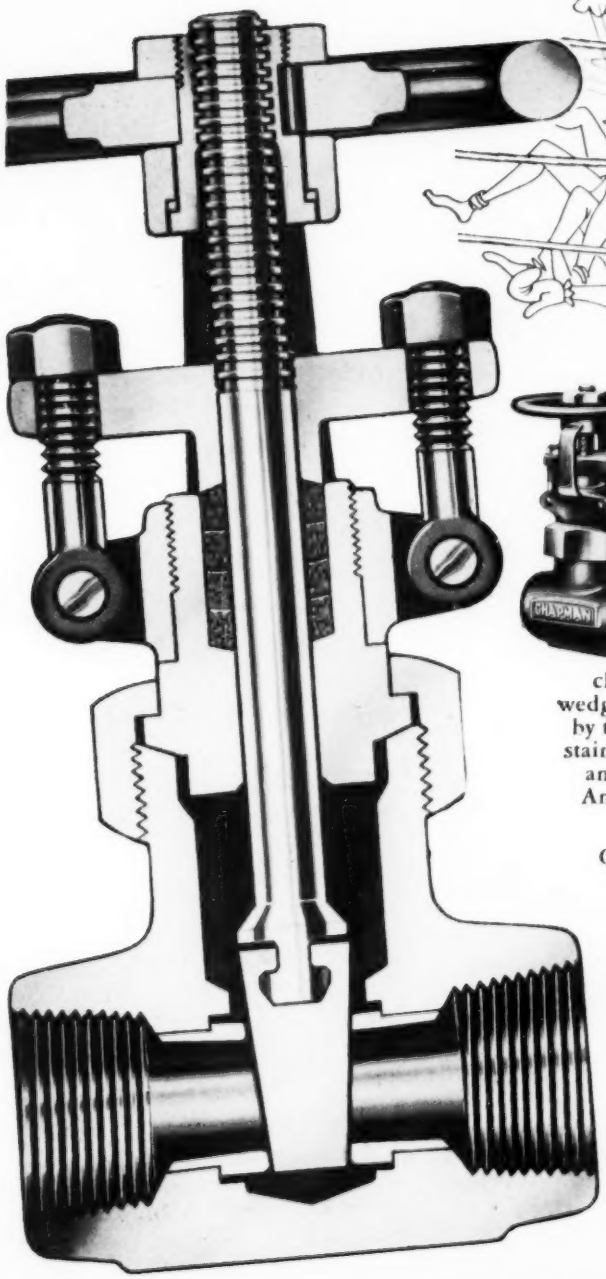
CHAPMAN LIST 960

Holds More Titles...

than any valve of its kind



Yes, here's the champ of all small forged steel gate valves! It has licked more different jobs than you can shake a stick at . . . and stays in there fighting with all the *extra stamina* you get in *every* Chapman Valve.

Here are the reasons why: Extra protection against even unusual stress when opening and closing the valve is provided by extra-strong stem-and-wedge-gate connection. Repairs and replacements are cut by the use of super-hardened seat rings and gate faces of stainless steel. Forged body and yoke are longer-lived . . . and bolted follower has no threads on yoke to corrode. And lastly, gate faces won't seize or gall because they're *Malcomized* (Chapman patent) to 800 Brinell.

Chapman List 960 Forged Steel Gate Valves are made in sizes from ½" to 2" inclusive . . . with rising stem with yoke (shown) or with rising stem with inside screw. Bonnet joints are either gasketed or metal to metal. Pressure range: 2,000 lb. at 100° F. — 380 lb. at 1,000° F. For higher pressures, specify List 990. And for full details on List 960, send today for your copy of Catalog 10.

THE CHAPMAN VALVE MFG. CO.

INDIAN ORCHARD, MASS.

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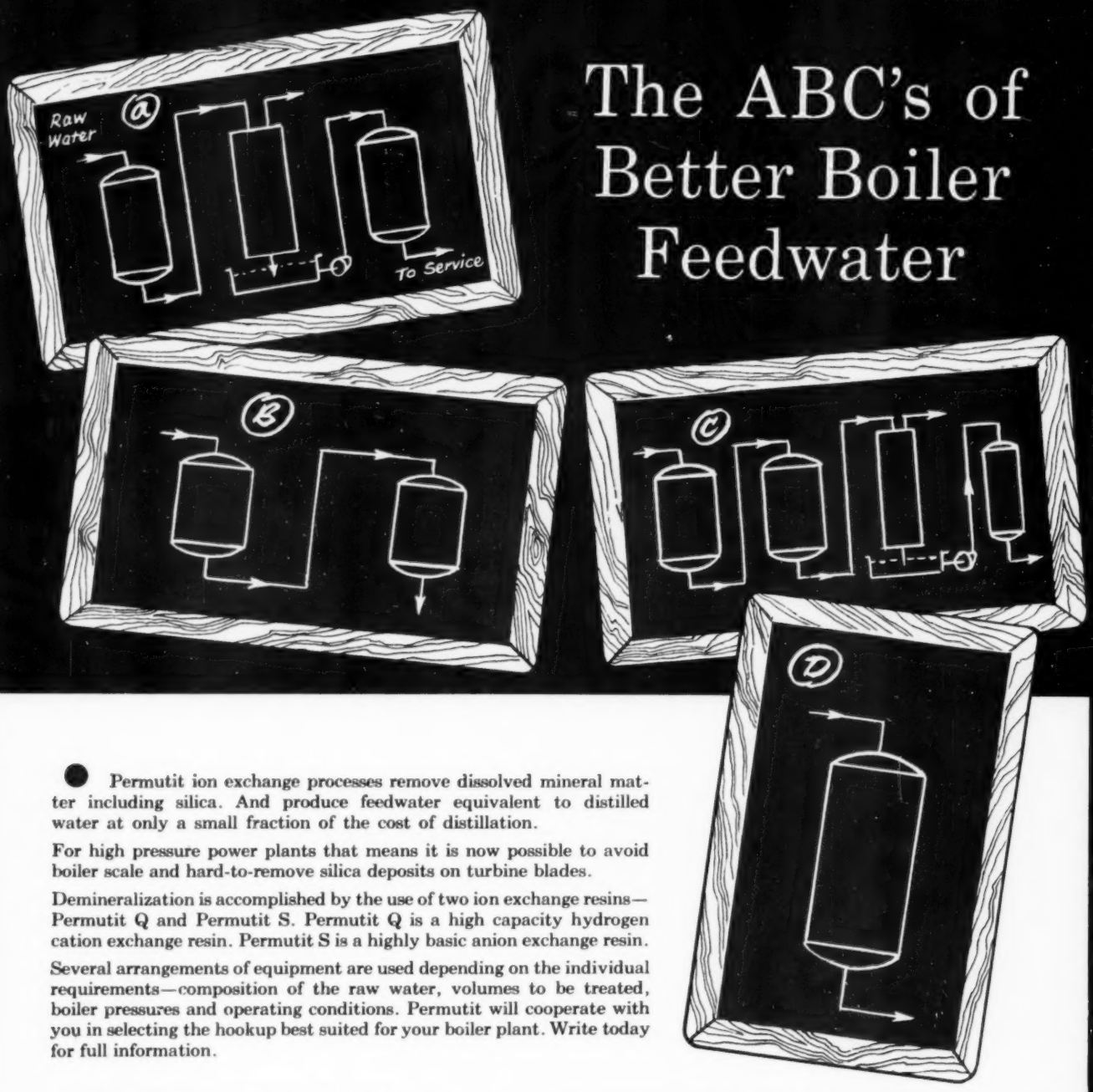
The ABC's of Better Boiler Feedwater



● Permutit ion exchange processes remove dissolved mineral matter including silica. And produce feedwater equivalent to distilled water at only a small fraction of the cost of distillation.

For high pressure power plants that means it is now possible to avoid boiler scale and hard-to-remove silica deposits on turbine blades.

Demineralization is accomplished by the use of two ion exchange resins—Permutit Q and Permutit S. Permutit Q is a high capacity hydrogen cation exchange resin. Permutit S is a highly basic anion exchange resin.

Several arrangements of equipment are used depending on the individual requirements—composition of the raw water, volumes to be treated, boiler pressures and operating conditions. Permutit will cooperate with you in selecting the hookup best suited for your boiler plant. Write today for full information.

A **TWO STEP WITH DEGASIFIER:** In large demineralizing plants, a degasifier is usually included as an inexpensive means for removing carbon dioxide.

B **TWO STEP WITHOUT DEGASIFIER:** No repumping required. Used where total quantities are not very great or with waters of low bicarbonate content.

C **THREE STEP WITH DEGASIFIER:** Extremely economical and effective arrangement for waters containing relatively high amounts of sulfates and chlorides.

D **MIXED BED:** An extremely compact arrangement. Both cation and anion exchangers are in the same unit. Used alone or as a final step.

The equipment described is also furnished in multiunit arrangements to treat whatever quantities of water are required and to meet all operating conditions.

PERMUTIT®

ION EXCHANGE AND WATER CONDITIONING HEADQUARTERS